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Analysis and Formulation of Food Crop Policy for Indonesia

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Abstract
This study of Indonesia's food policy formulation was initiated in February 1989. The study, conducted in collaboration with the Ministry of Agriculture, was funded by the U.S. Agency for International Development. Junior Minister Sjarifuddin Baharsjah of the Ministry of Agriculture, and Faisal Kasryno, director of the Bureau of Planning, were on the study's steering committee and helped to plan, organize, and implement the study and associated workshops. Their support of efforts to enhance the Ministry's capabilities for policy analysis greatly benefited the course of study activities.

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PREFACE

This study of Indonesia's food policy formulation was initiated in February 1989. The study, conducted in collaboration with the Ministry of Agriculture, was funded by the U.S. Agency for International Development. Junior Minister Sjarifuddin Baharsjah of the Ministry of Agriculture, and Faisal Kasryno, director of the Bureau of Planning, were on the study's steering committee and helped to plan, organize, and implement the study and associated workshops. Their support of efforts to enhance the Ministry's capabilities for policy analysis greatly benefited the course of study activities.

In addition, Marcus Winter, Robert Navin, and George Like of USAID-Indonesia helped to plan, implement, and guide the progress of the study. Stanley R. Johnson, William H. Meyers, and Helen H. Jensen of the Center for Agricultural and Rural Development (CARD) at Iowa State University were principal investigators for the study; Paul Heytens was the study's chief of party in Indonesia.

This report provides documentation of the food crop policy models developed through CARD's collaborative study with the Ministry of Agriculture. Three models were documented, each to be run using microcomputer-based spreadsheet software such as Lotus 1-2-3.

Several CARD staff members contributed to the writing of this report: Basile Goungetas wrote Chapter 2 on the National Food Demand Projections Model; Paul Heytens wrote Chapter 3 on the National Food Crop Policy Model; and T. Kesavan wrote Chapter 4 on the Regional Food Crop Policy Model. Helen Jensen and Paul Heytens wrote Chapter 1 and edited the final report.

CHAPTER 1. OVERVIEW OF ANALYSIS AND FORMULATION OF FOOD CROP POLICY

Indonesia is experiencing a rapidly changing economic environment and implementing economic reforms directed at moving away from an administered economy to one more responsive to domestic and international economic forces. Currently, economic planning and reform in Indonesia are being guided under Repelita V. Within the agricultural sector, the changes introduced under the Fifth Plan include a reduction in agricultural input subsidies, relaxation of commodity production target setting, diversification and regionalization of agricultural production and distribution systems, rationalization of pan-territorial pricing, and greater alignment and integration with international markets and other sectors of the economy.

Changes both within the Indonesian economy and in international markets will influence growth of the agricultural sector, as well as the implementation of policies designed to meet the objectives of Repelita V. Rising incomes and changes in the demographic composition of the population have led to changes in food consumption patterns that place increasing demands on the development of food processing and the livestock industry. Furthermore, differential growth and specialization in regions within Indonesia have led to specialized patterns of change in consumption and production, and have emphasized the importance of regional planning. These changes, in turn, have important implications for the development of the feed sector, for regulation of the food processing and distribution in the food sector, for the interaction between regional and national planning and policies, and for developing investment strategies in the agricultural sector.

The Ministry of Agriculture (MOA) plays an important role in developing and analyzing policies and programs for the agricultural and food sectors in Indonesia. Financed by the Agency for International Development in Indonesia (USAID/Jakarta), the Center for Agricultural and Rural Development (CARD) at Iowa State University collaborated with the MOA on a study designed to strengthen the capacity of the MOA to conduct policy analysis, and to support the formulation and implementation of a more market-oriented food crop policy.

See Appendix A for a list of the technical papers and research briefs produced under the CARD/MOA study.

Study Activities

Collaboration and development of improved capacities for policy analysis within the MOA occurred in three areas: diversification and analysis of commodity demand trends, national food crop policy options, and regional food crop policy strategies.

During the course of the 17-month study, CARD delineated plans for work and collaboration in four areas. CARD staff, in collaboration with MOA staff, developed consistent data sets, methods and techniques for policy analysis, and tools for policy analysis that are relatively easy to adopt and use within the MOA. Training in and analytical skills transfer of the techniques and tools were accomplished through on-the-job training of MOA staff, workshops, seminars, and special studies.

Diversification and Analysis of Commodity Demand Trends

The analysis of commodity demand trends under way in Indonesia used the data from a series of national consumer expenditure surveys (SUSENAS) to describe food consumption trends and to develop analytical capacity in support of investigations within the MOA of factors affecting demand changes. Using the 1981, 1984, and 1987 SUSENAS, data sets were developed at the Center for Agroeconomic Research (CAER) to support the initial analysis. Researchers and programming staff at CAER participated in training activities associated with this aspect of the data analysis (summarized in Technical Papers 3 and 4). Behavioral parameters for price, income, and response to changes in population structure (age and sex composition) were estimated from the SUSENAS data for urban and rural areas on- and off-Java. The demand system was consistent with economic demand theory and was estimated in a manner that allowed the computation of specific commodity price and income elasticities within specific food groups, as well as of total food and nonfood expenditures (see Technical Paper 1).

The estimated behavioral parameters formed the basis of the analytical framework for making and evaluating the projections of food consumption trends. This projections model is documented in Chapter 2 and in Technical Paper 10. The parameters estimated from the 1987 SUSENAS were used as the basis for initial baseline projections. Population projections from the Central Bureau of Statistics, constant relative prices with overall increases of 6 percent per year, as well as real income growth of 5 percent for each of the four regions, provided the remaining baseline assumptions.

Projections for the 1988-95 period, under such assumptions, showed rice consumption to grow at an average annual rate of 2.06 percent for all of Indonesia (Research Brief 22). Within Indonesia, the rates of growth were higher off-Java and in urban areas. These projected levels of increase in rice consumption are below the 3.2 percent level of growth projected under Repelita V, which uses a similar set of assumptions. Repelita V projections, however, do not include the effects of any nominal change in prices.

The model was designed so that alternative scenarios with different price, income, and population growth assumptions can be compared (as described in Research Briefs 20, 21, and 22). Changes in projected relative prices of foods, rates of income growth, and relative population growth in the four regions change the growth rate and distribution of the projected consumption of food commodities. For example, faster income growth on-Java (8 versus 5 percent) raises projected average annual growth of total rice consumption to a 2.48-percent level. Also, relatively large annual growth rates for red meats and poultry consumption are projected (5.15 and 3.40 percent, respectively). Both red meat and poultry consumption are relatively sensitive to the assumptions of own-price and income changes. Increases in total real expenditures (income) or a fall in relative poultry prices would increase projected poultry consumption substantially.

National Food Crop Policy Options

The development of a National Food Crop Policy Model for Indonesia provided the basis for a set of policy briefs and activities designed to evaluate alternative policy options at the national level. The model was based on earlier national policy models and was adapted and updated to provide a relatively straightforward modeling system based on the calculation of food balance sheets for important food crops. This model, documented in Chapter 3 and in Technical Paper 2, includes direct linkages to international commodity markets through projected levels of world prices and mechanisms for transmission to domestic markets. The model contains a component designed specifically to evaluate feed use by the livestock sector (Technical Paper 11).

The baseline set of assumptions were derived from levels of growth and prices simulated to be consistent with Repelita V food production objectives and projected exogenous growth rates in crop areas and yields. Projections developed from the baseline set of assumptions showed that despite the substantial run-up in real food crop prices during the 1986-88 period, steady increases in real prices are necessary during Repelita V to achieve food crop self-sufficiency targets. Furthermore, real price increases in food commodities would constrain, somewhat, growth in the industrial and services sectors, and therefore overall gross domestic product (GDP).

Alternative policy scenarios that were simulated (Research Briefs 1, 2, 6, and 13) included use of the world commodity price projections from CARD/FAPRI to assess the impact of opening up Indonesia's agricultural markets to free trade. Scenarios of constant real agricultural commodity prices during Repelita V and implementation of a policy package designed to induce production diversification were evaluated also. The alternative simulations illustrated, among other policy outputs, the importance of intercommodity effects of price policy changes. For example, the world price simulation suggests that a liberalization of agricultural trade must be sectorwide rather than crop specific for desired outcomes, such as trend self-sufficiency in rice and increased corn production, to occur. Similarly, the diversification simulation indicates that there is a tradeoff between rice self-sufficiency and diversification if the latter food policy objective is pursued through a strategy of differential output pricing and area targets.

The livestock component of the national model indicates substantial use of corn and soybeans as animal feeds in direct competition with human consumption (Research Brief 16). The baseline projections show strong growth in the use of food crops as feed inputs into the livestock sector during the 1990s. The major demander of feedstuffs is the commercial poultry industry, although modern hog operations and village-level poultry producers also utilize significant levels of feed inputs.

Regional Food Crop Strategies

Decentralization of agricultural planning and the growth and specialization of the agricultural production and processing sectors in Indonesia require developing the capacity for policy analysis at the regional level. The regional policy work focused on methods and approaches for developing analytical capabilities at this level. South Sulawesi was selected as the location of the initial pilot study, and Lampung was later added as a second study site.

Analysis and training at the regional level focused on developing and implementing methods and procedures for collecting and constructing consistent data series for the region (Technical Paper 8). Training regional staff in the collection of such data was an important product of the regional study activity.

To implement the regional system, a relatively simple framework was developed to analyze regional agricultural policies, with prices for commodities traded at the national level given; that is, determined exogenously to the region. This is documented in Chapter 4 and in Technical Paper 9. Under a baseline simulation, conducted under assumptions consistent with Repelita V growth rates and price levels, South Sulawesi's soybean and corn areas increased at annual rates of 5.06 and 2.34 percent, respectively. Increases in corn yields were projected larger than those of cassava and rice, and surplus rice availability was projected for South Sulawesi during each year of the Repelita V period.

With an assumption of relatively higher corn and soybean prices, as under policies supporting food crop diversification, South Sulawesi's area harvested in soybean and corn increased, as expected, although yield increases were not substantial in soybeans. Much of the increase in soybean production came through switching areas from rice production to soybeans, indicating tradeoffs at the regional level of crop diversification policies.

Study activities undertaken in Jakarta and Bogor had a regional focus as well. Supply and demand parameters for important food crops in South Sulawesi and Lampung were estimated at CAER (Technical Papers 5 and 6) and incorporated into the regional policy analytical frameworks. The data collection and model development activities were coordinated through the Bureau of Planning (BOP), Jakarta, to foster better communication between policymakers in the center and provincial officials.

Analytical Skills Transfer

Training in and analytical skills transfer of the techniques and tools applied in policy analysis were accomplished through on-the-job training of MOA staff during workshops, seminars, and special studies. Most significantly, the transfer included formal training programs and detailed model documentation produced in connection with each of the major analytical systems developed under the three main study activities. The training focused on methods and procedures necessary to institutionalize the use of the modeling systems by MOA staff. For each of the analytical systems, the training focused on four activities necessary to operationalize the use of the models:

- Data compilation and management
- Model specification and parameter estimation
- Updating and revision of analytical models
- Model application--policy analysis and projections

The MOA will then have the capability to use the models for policy analysis as well as to update and revise the analytical systems as new data become available and as the economic and policy environment changes.

The implementation of the CARD modeling systems, summarized in Table 1.1, would support a policy analysis orientation for CARD's counterpart agencies, particularly the Bureau of Planning. The CARD/MOA analytical system, comprising the National Food Crop Policy Model, the National Food Demand Projection Model, and the Regional Food Crop Policy Model, is a comprehensive tool for food policy analysis. As Table 1.1 indicates, the various system components are based on readily available data in Indonesia, utilize behavioral parameters estimated from those data, incorporate analysts' assumptions about policy and technical variables, and produce outputs that can be used to evaluate and monitor the impacts of policy changes on the food crop sector. The scope of food policy issues that can be addressed with the analytical systems is broad, ranging from the implications of alternative price policies for future food demand trends to the trade implications of the deregulation of food commodity markets.

Recommendations and Implementation of the CARD/MOA Analytical Systems

With the CARD/MOA modeling systems, the MOA can analyze a broad range of food policy issues and project future food crop supply, demand, and trade balances. This capacity would enable the MOA to produce regular policy briefs analyzing important food policy issues and to provide situation and outlook reports describing current and possible future conditions in the agricultural economy.

There are a number of advantages to this arrangement. The MOA, traditionally, has not had a major input into the analysis and formulation of agricultural price and trade policy. Use of the CARD/MOA modeling systems to produce policy briefs analyzing agricultural policy issues and regular production of sector outlook papers would enhance greatly its standing in

Indonesia's agricultural policy arena. Further, implementing and institutionalizing the policy models is timely since the system lends itself to broad analysis of the impacts of economic deregulation and the transition to a middle income economy for the agricultural sector--processes currently occurring in Indonesia. Use of the models for such a purpose would place the MOA in the vanguard of analyzing the economic implications of policy deregulation and, more generally, economic transformation. This, in turn, would place the MOA in a position to assume a more prominent role in Indonesia's agricultural policy formulation process.

The institutionalization of the policy models has direct implications for the orientation of the Bureau of Planning and how the BOP interacts with other agencies within the Ministry of Agriculture. A diagrammatic representation of the intraministerial linkages and information flows implied by implementing the analytical systems is shown in Figure 1.1. As the diagram indicates, maintenance and use of the analytical systems requires cooperation among the BOP, the CAER, and the regional planning offices (KANWIL). The nature of the linkages between and among institutions varies depending on the analytical system described in each model and documented in this report. However, close cooperation between agencies to effect a regular exchange of information is crucial to successful operationalization.

The division of labor within the MOA reflects the underlying comparative advantage of the relevant agencies. The Bureau of Planning, because of its newly decreed function as a planning and analysis body, is well-suited to actual application of the models and managing the information that the analytical system produces. The CAER, because of its extensive computing facilities and expertise in econometric methods, is the logical place to compile data, process the SUSENAS data, and estimate the behavioral parameters. The provincial KANWILs are best suited to gathering primary data at the regional level.

The probability of successful institutionalization of the analytical systems would be increased greatly if the Bureau of Planning were to make a firm commitment to take on a policy analytic mission and to publish and distribute model results in the form of policy briefs, situation reports, and outlook reports. Stated simply, institutionalization becomes more likely if the objectives of the implementing agency, the BOP, are consistent with the outputs of the analytical models. A core of well-trained staff in the BOP and a commitment by its leaders to use the models and disseminate the analytical results are necessary to effect successful institutionalization. This requires that expert staff, namely those with Ph.D.- and M.A.-level training in the BOP, be given the time and instruction necessary to use the models. In addition, successful implementation requires that the institutional linkages shown in Figure 1.1 be established and sustained.

Detailed documentation of the modeling systems developed by CARD is provided in the next three chapters. The write-ups place each component of the analytical system in a policy-related context and describe the structure (i.e., equations) and the economic behavioral content of the models. The use of each of the models as a tool for policy analysis is illustrated with numerous applications to important food policy issues in Indonesia.

Table 1.1. Overview of CARD analytical systems

	Food Demand Projection Model	National Food Crop Policy Model	Regional Food Crop Policy Model
Data Requirements	National consumption surveys Sociodemographic composition	Historical cultivated area and yields Food balance sheets National accounts data Animal population data	Historical cultivated area and yields Food balance sheets Regional accounts data
Behavioral Parameters	Own and cross-price demand elasticities Consumption expenditures elasticities Demographic growth	Supply response elasticities Consumption elasticities Input demand elasticities Macroeconomic growth parameters	Supply response Consumption elasticities Input demand elasticities
Policy and Technical Assumptions	Income growth Consumer prices Population growth	Input and output prices Mining/defense sector growth Technical change Area trends Feed ration composition Animal population growth	Input and output prices Nonagricultural regional product Technical change Area trends
Policy Outputs	Future food demand trends Aggregate nutritional adequacy Budget shares/composition of food expenditures	Aggregate/national farm and rural income Aggregate input use Market balance (trade/stocks) GDP and sector growth rates Aggregate feed demand by livestock sector	Regional farm and rural income Regional input use Regional market surplus/deficit

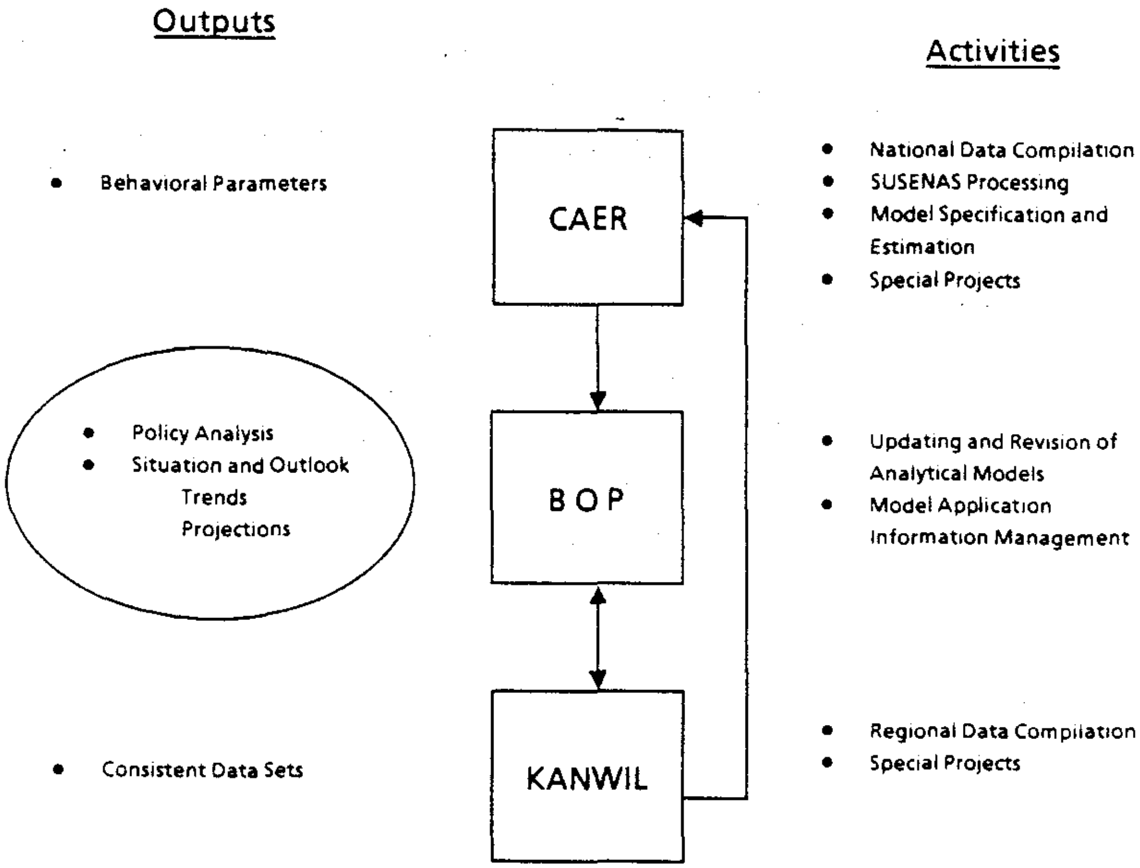

Figure 1.1. Schematic representation of CARD/MOA policy analysis and information system.

CHAPTER 2. A NATIONAL FOOD DEMAND PROJECTIONS MODEL FOR INDONESIA

Indonesia, like many developing countries, is facing rapidly changing food consumption patterns and new methods of food production. Rising incomes, as well as economic reforms affecting prices, have altered the structure of consumer demand and are creating different food crop requirements. These events have significant implications for many agricultural and food policies. Changing consumer demand directly relates to food policy development, food use projections, regional specialization, adaptation of secondary food crops, and livestock feed requirements. In addition to changing prices and income, a broad range of sociodemographic and regional growth factors affect the patterns of food consumption projected for both intermediate and longer term economic planning.

Indonesia has invested in an extensive series of national consumer expenditure surveys (SUSENAS) from which comprehensive data sets are presently available. The sample sizes of these surveys are sufficiently large to support investigation of regional differences in food consumption and expenditure patterns. The survey data include detailed information on expenditures and consumption of households as well as their sociodemographic profiles.

The information from SUSENAS provided the basis for the development of the CARD/MOA National Food Demand Projections (NFDP) model, which can be used to analyze changes of food demand patterns under alternative policy scenarios. The NFDP model is driven (1) by estimated food demand response parameters and (2) by assumptions about the change over time in the size of different population groups, commodity prices, inflation, and real income. The policy analyst need only specify alternative assumptions for the demographic variables, commodity prices, and income in order to obtain the food demand projections.

This chapter documents the NFDP model, that is, the description of the structural model that was used to generate the parameter estimates, the data sources, the estimation procedure, the projection methods, and the results from some policy simulations.

The Structural Model

The system of demand equations used to obtain the parameter estimates on which the NFDP model is based was constructed assuming a multiple stage budgeting process (Deaton and Muellbauer 1980; Phlips 1983). Specifically, the system includes a four-stage budgeting process (Figure 2.1) with households making sequential and related consumption decisions. Households were assumed to first allocate their disposable income between savings and current expenditure (consumption). This first stage was not modeled in this study. In a second stage, households were assumed to allocate their total current expenditure among four categories: food commodities, housing, clothing, and other nonfood items. The third stage involved the allocation of total food expenditure among 10 broad food groups (Table 2.1). Finally, a fourth stage involved the allocation of the expenditure on the palawija crops and on meat/fish to more detailed items within these two food groups. Thus, consumption among meat and fish items, for example, depends on the prior allocation decision among all food commodity groups for the "meat/fish" group.

Under conditions of weak separability, the Marshallian demand equations for the commodities in the r^{th} stage can be written as (Phlips 1983)

$$x_{ri} = g_{ri}(P, y) = f_{ri}(P_r, y_r), \tag{2.1}$$

where x_{ri} is the demand for commodity i (i = 1, 2, ..., n_r) in the r^{th} stage (r = 1, 2, ..., R), P is the vector of all commodity prices, P_r is the vector of prices for the commodities in the r^{th} stage, y is total expenditure, and y_r is expenditure on all commodities in the r^{th} stage.

The Linear Approximate Almost Ideal Demand System (LA/AIDS) was used to estimate the demand equations (2.1). The Marshallian demand equations, in share form, for the LA/AIDS demand system are

$$w_{ri} = \alpha_i + \sum_j \tau_{rij} \ln(p_{rj}) + \beta_{ri} \ln(y_r/P_r) \ ; \ i, j = 1, 2, \ldots, n_r, \tag{2.2}$$

where $w_{ri} = (p_{ri}x_{ri})/y_r$ is the budget share of the i^{th} commodity, p_{rj} is the price of the j^{th} commodity, and P_r is Stone's price index,

$$\ln(P_r) = \sum_k w_{rk} \ln(p_{rk}). \tag{2.3}$$

A set of demographic variables was introduced into model (2.2) by translating the intercept term. Thus, it was assumed that

$$\alpha_{ri} = \alpha_{ro} + \sum_s \alpha_{ris} D_s \ ; \ i = 1, 2, \ldots, n_r,$$

where the Ds denote demographic variables. The resulting model was

$$w_{ri} = \alpha_{ro} + \sum_s \alpha_{ris} D_s + \sum_j \tau_{rij} \ln(p_{rj}) + \beta_{ri} \ln(y_r/P_r). \tag{2.4}$$

The relevant theoretical restrictions that can be imposed on this demand system are (Heien and Pompelli 1989)

Symmetry: $\tau_{rij} = \tau_{rij} (i = j \; ; \; i, \; j = 1, \; 2, \ldots, \; n_r),$ (2.5a)

Homogeneity: $\sum_j \tau_{rij} = 0 \quad (i = 1, \; 2, \ldots, \; n_r),$ (2.5b)

Adding-up: $\sum_i \alpha_{rio} = 1; \quad \sum_i \alpha_{ris} = 0; \quad \sum_i \tau_{rij} = 0; \quad \sum_i \beta_{ri} = 0.$ (2.5c)

Data Sources

The available data on food and nonfood consumption, and the age-sex composition of households from three SUSENAS--1981 (spring quarter only), 1984, and 1987--were used to estimate model (2.4). The SUSENAS were conducted throughout the entire geographical area of Indonesia using a multistage sampling design that differentiated between urban and rural areas. This allowed estimating a model covering all national regions. At the final sampling stage, a number of households was drawn from the selected primary sampling unit (PSU) in a systematic fashion. Only the estimates based on the 1987 SUSENAS were used for the construction of the NFDP model.

The demographic variables used were five age/sex categories into which every household member was classified. For the purposes of this study, the information on individual households within each PSU was aggregated to obtain what hereafter is referred to as a <u>representative household</u> (Ray 1982). That is, average values of expenditures and demographic variables were obtained at the PSU level. This was done for two reasons: (1) to reduce the very large number of records involved to a smaller and more manageable number and (2) to alleviate, to some extent, the problem of nonconsumption by individual households of certain food items during the time of the interview. The time reference was one week for food items and one month and/or one year for nonfood items.

All food items were classified into one of the ten food groups, and the corresponding subgroups listed in Table 2.1. Economic theory does not provide any guidance on the number or composition of food groups. The construction of the food groups used in this study was influenced by past studies of the Indonesian food sector, by the planned policy analysis, and by a classification reflecting the similarity of food commodities from a consumer's viewpoint.

Unit prices for food items were obtained by dividing the reported expenditure by the reported quantity. Following Heien and Pompelli (1989), auxiliary regressions linking available prices to a set of dummy variables and total expenditure were used to impute the missing prices.

For all nonfood items and for several food items (usually the so-called "other" category within each food group), the reported quantity was not defined. This was so because these categories contained an assortment of different items that were not measured in the same unit. Consequently, the unit price could not be obtained in such cases.

Price indexes were used, instead, as reported by the Central Bureau of Statistics for major capital cities in most provinces of Indonesia (Biro Pusat Statistik 1988). The reported value for each city was used for all PSUs in the province where that city belonged. For provinces with no city reporting, the values of the geographically closest city were used. In order to express all prices in the same metric, both the food price (from the 1987 SUSENAS) and the price indexes for the nonfood categories were scaled by dividing each by its mean value.

Within each budgeting stage, all PSUs that did not report consumption of one or more commodities were not used in the estimation. Sample averages for the demographic variables and budget shares involved in each budgeting stage are reported in Table 2.2.

Estimation of Behavioral Parameters

Model (2.4) was estimated separately for urban and rural areas on- and off-Java, with restrictions (2.5a) through (2.5c) imposed. The SAS procedure SYSNLIN and the method of Iterative Seemingly Unrelated Regressions (ITSUR) were used for the estimation. Because the error variance-covariance matrix of the full model is singular, at each budgeting stage one equation was dropped from the estimation, and its parameters were "recovered" later using the adding-up restriction. The ITSUR procedure results in consistent parameter estimates and is asymptotically equivalent to the Maximum Likelihood Estimation technique, which is invariant to the equation being dropped.

A summary of the own-price and expenditure elasticities for all budgeting stages and of region/urbanization combinations based on the 1987 survey is given in Tables 2.3 through 2.6. These figures were extracted from the full set of elasticity tables (CARD/MOA Technical Paper 10, Tables 5 through 20) and were computed using the estimated parameters from model (2.4), the sample average values of the appropriate variables (Table 2.2), and the following formulas (the subscript r has been dropped for clarity):

Own-price elasticity: $e_{ii} = -1 + (\tau_{ii}/w_i) - \beta_i$,

Cross-price elasticity: $e_{ij} = (\tau_{ij}/w_i) - (\beta_i w_j/w_i)$; $i \neq j$,

Expenditure elasticity[1]: $\epsilon_{iy} = 1 + (\beta_i/w_i)$,

Demographic elasticity: $\epsilon_{is} = \alpha_{is} D_s/w_i$.

The figures reported in Tables 2.3 through 2.6 indicate a significant variability in the elasticities among the four regions. For instance, the demand for rice appears to be highly price inelastic in urban areas and moderately inelastic in rural areas. The demand for palawija crops and prepared food appears to be price elastic in all regions except urban Java. With few exceptions, the expenditure elasticities are almost the same across the four regions. In general, for those commodities that can be compared with data from other studies of the Indonesian food sector, the results reported here are similar to those reported elsewhere, such as in Deaton (1988).

Food Demand Projections

Changes in population growth, relative prices, total real expenditure, age/sex composition, and regional population shifts have significant implications for food demand in Indonesia. Therefore, it is imperative to understand how such economic and demographic changes will affect future consumer demand.

Assuming constant consumer preferences over time, the CARD/MOA NFDP model generates food demand projections by combining the demand response parameters from model (2.4) with future demographic projections and expectations about the future course of commodity prices and of real total expenditure. The procedures for calculating the food demand projections are described in Appendix B.

For the baseline projection, the demographic information used in the NFDP model was obtained from the population in age/sex groups for each province, as published by the Indonesian Central Bureau of Statistics. Real total expenditures were assumed to grow at a 5 percent rate in the baseline. And, in the absence of information on the future course of prices, a fixed relative real prices scenario was used. Of course, alternative price scenarios can also be utilized as is shown in the next section.

The NFDP model was built as a LOTUS 1-2-3 spreadsheet file for each of the four regions (urban Java, rural Java, urban off-Java, and rural off-Java). The projections generated by the NFDP model, at the representative household level, are budget shares, total expenditure, and growth rate in total consumption; and at the regional level are growth rate in both total expenditure and total consumption. Appendix C describes the spreadsheet files and how the model is run.

The regional projections generated by the NFDP model are combined to compute national projections. The results at the national level were computed as a weighted average of regional projections, with the weights being the 1985-95 average population shares of Java and off-Java in the total population of Indonesia. These weights were normalized and set to 1 for urban and rural off-Java and 1.4876 for urban and rural Java.

Policy Applications

The use of the NFDP model as a useful tool for policy analysis is illustrated by the baseline projections and three comparative applications.

The Baseline Scenario

The baseline scenario uses the population growth rates as projected by the Indonesian Central Bureau of Statistics, and assumptions of fixed relative prices increasing at 6 percent annually (the expected inflation rate) and of real income or total expenditure in each of the four regions (urban Java, rural Java, urban off-Java, rural off-Java) increasing at 5 percent annually for the period 1988 to 1995.

The projected consumption growth for all commodities under this scenario is reported in Table 2.7. All projected consumption growth rates are positive and reflect both the changes in the demographic profile of Indonesia and the assumed income growth. According to these projections, the consumption of all nonfood categories will grow faster than food consumption, and the consumption of all food commodities will grow faster than the consumption of rice. Among specific food commodities, prepared food, palawija crops, and fruits and vegetables show the highest growth rates.

Rice Consumption

Rice consumption trends are of central importance in the development of food and agricultural policies in Indonesia. In this application, rice consumption growth estimates for the four regions and all of Indonesia are obtained under alternative price and income assumptions. The corresponding projections are summarized in Table 2.8.

The CARD/MOA baseline projects rice consumption to increase at an average annual rate of 2.06 percent. A fall in relative rice prices, faster income growth off-Java, or faster income growth on-Java all boost consumption growth above this level. Only slower income growth off-Java implies a lower growth rate for rice consumption. The implications of these results for policymakers concerned with maintaining Indonesia's rice self-sufficiency is that rice production most likely will have to grow at well over 2 percent annually to meet the trend in consumption growth.

Red Meat and Poultry Consumption

The livestock industry is receiving increased attention from policymakers as Indonesia enters the 1990s. This is so for several reasons: important deregulation issues are pending in the poultry sector; the livestock sector is seen as a crucial component of a more general promotion of agribusiness development in Indonesia; and the use of domestic crop production as an input into the livestock industry has increasingly been seen as an economically efficient way of adding value to primary agricultural production. This policy application uses the NFDP model to assess the implications of alternative price and income growth scenarios for the consumption of red meat and poultry.

Eight alternative scenarios, including the CARD/MOA baseline, are summarized in Table 2.9. Substantial growth in red meat and poultry consumption is projected under both the CARD/MOA baseline and most alternative scenarios. These scenarios suggest that the demand for both red meat and poultry is considerably responsive to price and income changes. The price scenarios also reveal the absence of significant cross-commodity price effects: there is little substitution away from red meat when the relative price of poultry falls, nor is there much substitution away from poultry when the relative price of red meat falls.

Overall, these scenarios suggest significant prospects for growth in demand for meat products in Indonesia. From a policy standpoint, the red meat and poultry results indicate that the domestic market could become a source of rapid growth for the livestock industry in the first half of the 1990s.

Alternative Regional Income Growth Scenarios

The regional distribution of income growth has important implications for future food consumption. In developing countries, regional variations in economic growth are often very large. Indonesia is no exception: during the 1980s, economic growth on-Java was considerably greater than in off-Java areas. One of the goals of Repelita V and other national development efforts is to accelerate economic growth in the outer islands. This application uses the NFDP model to assess the implications of different assumptions for regional income growth for the consumption of rice, cereals, poultry, and sugar/condiments.

Projections from five alternative regional income growth scenarios along with the CARD/MOA baseline are shown in Table 2.10. These projections suggest that income growth on-Java is a considerably more important determinant of future national food demand than that off-Java. Higher relative income growth rates in Java, the most likely course of events in the 1990s, result in more rapid national food consumption growth off-Java. This is due to both Java's larger population and its relative differences in expenditure elasticities among the regions.

From a practical policy standpoint, these results underscore the point that although food production will almost certainly move off of Java, food consumption probably will not. This suggests that plans and investments must be made now to ensure that transport, storage, and processing infrastructure will be adequate to utilize and move foodstuffs from production centers in the outer islands to consumption centers in Java.

Conclusion

The CARD/MOA NFDP model for Indonesia described in this chapter is region-specific and, as illustrated by these applications, can be a very useful analytical tool for evaluating the effect of alternative policy simulations on projected food demand trends. The model is flexible in the sense that it is readily possible to investigate the effects of different policy scenarios on future food demand trends. The multicommodity nature of the model, in particular, enables the policy analyst to study the importance of cross-price effects on future food consumption patterns.

Although the NFDP model is based on behavioral parameters estimated from the 1987 SUSENAS, it can be updated and run using parameters from previous or future surveys. This feature makes the NFDP model an important tool for assessing the effects of shifts in the conditions of the Indonesian economy, such as demographics, commodity prices deregulation, and income growth.

ENDNOTE

1. The expenditure elasticity is calculated with respect to expenditures at the respective budgeting stage, r. The expenditure elasticity with respect to total expenditures is calculated using information from prior budgeting stages. For example, there are three stages in the calculation of an elasticity for "beef and other red meats": allocation of (1) total expenditures, then (2) meats, and then (3) beef. The total expenditures calculations are as follows:

$$\epsilon_{fy} = 1 + (\beta_f/w_f) \qquad \text{(first stage)}$$

$$\epsilon_{my} = \epsilon_{my}^{*} \cdot \epsilon_{fy} \qquad \text{(second stage)}$$

$$\epsilon_{by} = \epsilon_{by}^{*} \cdot \epsilon_{my} \qquad \text{(third stage)}$$

where ϵ_{fy} = food expenditure elasticity elasticity, calculated at the first stage (with respect to total expenditures),

ϵ_{my} = meat expenditure elasticity with respect to total expenditures,

ϵ_{my}^{*} = meat expenditure elasticity calculated in the second stage estimation,

ϵ_{by} = beef expenditure elasticity with respect to total expenditures,

ϵ_{by}^{*} = beef expenditure elasticity calculated in the third stage estimation.

Note that ϵ_{fy}, ϵ_{my}^{*}, and ϵ_{by}^{*} are calculated at each stage, r, using the formula presented in the text:

$$\epsilon_{iy} = 1 + (\beta_i/w_i).$$

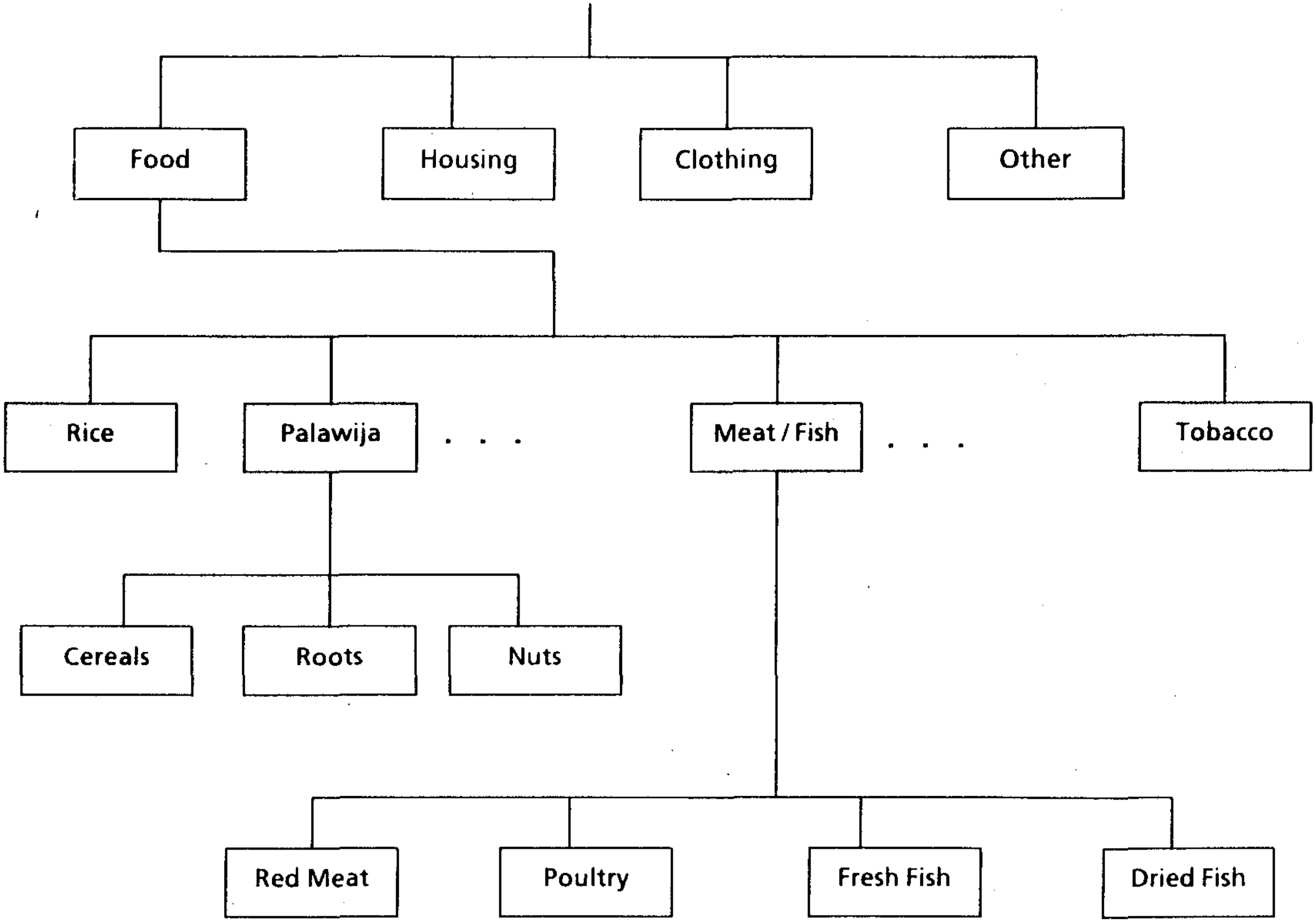

Figure 2.1. Decision tree for the last three stages of the budgeting process

Table 2.1. List of food groups and corresponding subgroups

1. Rice

2. Palawija Crops and Wheat
    - 2.1 Cereals
        - Corn
        - Wheat
        - Other cereals
    - 2.2 Roots
        - Cassava
        - Potatoes
        - Sweet potatoes
        - Other roots and tubers
    - 2.3 Beans and Nuts
        - Peanuts, mungbeans, soybeans, other beans and nuts
        - Processed beans and nuts

3. Fruits

4. Vegetables

5. Meat and Fish
    - 5.1 Beef and Red Meat
        - Beef (including beef liver, etc.)
        - Other red meat (goat, etc.)
        - Processed meat (dried, canned, smoked, etc.)
    - 5.2 Poultry
    - 5.3 Fresh Fish
    - 5.4 Dry/Preserved Fish

6. Eggs and Dairy

7. Fats and Oils

8. Sugar, Spices, and Condiments

9. Prepared and Other Food, Nonalcoholic Drinks

10. Alcoholic Beverages and Tobacco Products

Table 2.2. Sample averages of demographic variables and budget shares by region/urbanization, 1987 SUSENAS

	Region/Urbanization			
Variable	Urban Java	Rural Java	Urban Off-Java	Rural Off-Java
Demographic				
Average number of:				
Children	1.025	1.021	1.272	1.365
Females 10-19	0.590	0.466	0.671	0.544
Females 20+	1.354	1.210	1.308	1.209
Males 10-19	0.548	0.497	0.722	0.579
Males 20+	1.256	1.102	1.317	1.139
Budget Shares				
Food & Nonfood				
Food	0.547	0.675	0.583	0.733
Housing	0.214	0.165	0.195	0.121
Clothing	0.034	0.038	0.052	0.051
Miscellaneous	0.205	0.121	0.170	0.096
Food				
Rice	0.214	0.303	0.230	0.313
Palawija	0.065	0.100	0.049	0.070
Fruits	0.050	0.044	0.059	0.055
Vegetables	0.083	0.094	0.087	0.089
Meat/fish	0.130	0.084	0.189	0.150
Eggs and dairy	0.062	0.033	0.061	0.032
Fats and oils	0.044	0.053	0.044	0.052
Sugar and cond.	0.085	0.095	0.089	0.098
Prepared food	0.180	0.115	0.108	0.061
Tobacco, etc.	0.086	0.078	0.084	0.080
Palawija & Wheat				
Cereals	0.088	0.265	0.201	0.338
Roots	0.170	0.184	0.265	0.338
Nuts	0.742	0.551	0.534	0.324
Meat/Fish				
Beef, etc.	0.312	0.213	0.243	0.206
Poultry	0.248	0.254	0.157	0.189
Fresh fish	0.317	0.295	0.500	0.408
Dried fish	0.124	0.237	0.100	0.197

Table 2.3. Food-nonfood sector: Own-price and total expenditure elasticities, 1987 SUSENAS

Own-price

Region/ Urbanization	Commodity			
	Food	Housing	Clothing	Misc.
Urban Java	-1.091	-0.573	-0.091	-0.515
Rural Java	-0.935	-1.491	-0.386	-1.797
Urban Off-Java	-1.104	-0.880	0.025	-1.127
Rural Off-Java	-0.978	-0.826	-0.935	-1.300

Total Expenditure

Region/ Urbanization	Commodity			
	Food	Housing	Clothing	Misc.
Urban Java	0.884	1.067	1.083	1.226
Rural Java	0.885	0.963	1.191	1.630
Urban Off-Java	0.846	1.029	1.403	1.374
Rural Off-Java	0.904	1.010	1.272	1.578

Table 2.4. Food sector: Own-price and total expenditure elasticities, 1987 SUSENAS

Own-price

Region/ Urbanization	Rice	Pala-wija	Fruit	Veg	Meat/ Fish	Eggs/ Dairy	Fats	Sugar/ Cond.	Prepared	Tobacco
	Food Group									
Urban Java	-0.119	-0.731	-0.704	-0.682	-0.613	-0.615	-0.829	-0.816	-0.963	-0.838
Rural Java	-0.711	-1.574	-0.641	-0.891	-0.752	-0.692	-1.170	-0.796	-1.017	-1.028
Urban Off-Java	-0.177	-1.166	-0.710	-0.859	-0.780	-0.674	-0.939	-0.780	-1.075	-0.743
Rural Off-Java	-0.432	-1.314	-0.672	-0.765	-0.766	-0.775	-0.995	-0.720	-1.096	-0.775

Total Expenditure

Region/ Urbanization	Rice	Pala-wija	Fruit	Veg	Meat/ Fish	Eggs/ Dairy	Fats	Sugar/ Cond.	Prepared	Tobacco
	Food Group									
Urban Java	0.346	0.773	1.131	0.915	1.002	0.834	0.617	0.775	1.485	0.983
Rural Java	0.443	0.833	1.389	0.988	0.928	0.999	0.696	0.851	1.782	1.061
Urban Off-Java	0.257	0.938	1.345	0.915	0.897	0.739	0.792	0.807	1.503	1.183
Rural Off-Java	0.482	0.789	1.563	1.095	1.015	0.943	0.896	0.981	1.682	1.157

Table 2.5. Palawija and wheat sector: Own-price and total expenditure elasticities, 1987 SUSENAS

Own-price

Region/ Urbanization	Commodity		
	Cereals	Roots	Nuts
Urban Java	-1.495	-0.745	-0.920
Rural Java	-1.308	-1.102	-0.854
Urban Off-Java	-1.130	-0.915	-0.974
Rural Off-Java	-1.062	-0.930	-0.806

Total Expenditure

Region/ Urbanization	Commodity		
	Cereals	Roots	Nuts
Urban Java	1.371	0.793	0.699
Rural Java	1.475	0.852	0.525
Urban Off-Java	1.144	1.063	0.801
Rural Off-Java	1.005	0.822	0.546

Table 2.6. Meat and fish sector: Own-price and total expenditure elasticities, 1987 SUSENAS

Own-price

Region / Urbanization	Commodity			
	Beef	Poultry	Fr. Fish	Dr. Fish
Urban Java	-0.510	-0.734	-0.975	-1.002
Rural Java	-0.581	-0.789	-0.889	-1.002
Urban Off-Java	-1.107	-0.977	-1.234	-0.815
Rural Off-Java	-0.915	-0.720	-1.140	-1.125

Total Expenditure

Region/ Urbanization	Commodity			
	Beef	Poultry	Fr. Fish	Dr. Fish
Urban Java	0.955	0.887	1.071	1.142
Rural Java	0.664	0.690	1.019	1.191
Urban Off-Java	0.575	0.769	1.039	1.057
Rural Off-Java	0.741	0.684	1.145	1.280

Table 2.7. Consumption projections for Indonesia under the CARD/MOA baseline scenario

	Change (percent) from Previous Year							
Food/Nonfood Sector	1988	1989	1990	1991	1992	1993	1994	1995
Food	3.98	3.97	3.96	3.94	3.95	3.96	3.82	3.73
Housing	4.80	4.80	4.90	4.94	5.01	4.97	5.16	5.25
Clothing	5.45	5.57	5.43	5.43	5.32	5.43	5.35	5.36
Miscellaneous	7.25	7.21	7.14	7.11	6.99	6.91	7.15	7.28

	Change (percent) from Previous Year							
Food Sector	1988	1989	1990	1991	1992	1993	1994	1995
Rice	2.39	2.32	2.21	2.11	2.02	1.98	1.79	1.68
Palawija & Wheat	4.87	4.92	4.98	4.99	4.97	5.00	4.97	4.97
Fruits	4.92	4.88	4.73	4.67	4.62	4.70	4.43	4.33
Vegetables	4.30	4.31	4.28	4.27	4.29	4.29	4.01	3.78
Meat & Fish	4.10	3.99	4.01	3.96	3.99	3.94	3.87	3.82
Eggs & Dairy	3.81	3.82	3.88	3.88	3.86	3.89	3.75	3.62
Fats & Oils	3.68	3.69	3.67	3.66	3.65	3.66	3.52	3.43
Sugar & Condiments	4.03	4.07	4.10	4.12	4.14	4.15	3.99	3.85
Prepared Food	5.56	5.54	5.43	5.37	5.35	5.36	5.22	5.13
Tobacco, etc.	4.21	4.20	4.38	4.39	4.58	4.46	4.29	3.95

	Change (percent) from Previous Year							
Palawija & Wheat	1988	1989	1990	1991	1992	1993	1994	1995
Cereals	6.91	7.00	6.89	6.88	6.84	6.87	6.90	7.00
Roots	4.91	4.90	4.95	4.93	4.86	4.92	4.65	4.48
Nuts	3.90	3.94	4.02	4.02	3.97	3.97	3.94	3.89

	Change (percent) from Previous Year							
Meat/Fish	1988	1989	1990	1991	1992	1993	1994	1995
Beef & Red Meats	4.95	4.94	5.13	5.13	5.15	5.01	5.39	5.53
Poultry	3.54	3.45	3.46	3.42	3.42	3.36	3.29	3.22
Fresh Fish	4.32	4.16	4.22	4.17	4.25	4.16	4.00	3.85
Dried Fish	3.21	2.99	2.61	2.41	2.31	2.34	1.70	1.35

Table 2.8. Projections of rice consumption for Indonesia, 1988-95

	Projected Average Annual Change in Total Rice Consumption				
	On-Java		Off-Java		Total
Alternative Assumptions	Urban	Rural	Urban	Rural	
CARD/MOA Baseline[a]	1.84	1.29	2.80	2.81	2.06
Fall in Relative Rice Prices (3% vs. 6%)	1.31	2.95	2.76	3.49	2.53
Faster Income Growth Off-Java (7% vs. 5%)	1.84	1.29	3.11	3.65	2.29
Slower Income Growth Off-Java (3% vs. 5%)	1.84	1.29	2.38	2.09	1.83
Faster Income Growth On-Java (8% vs. 5%)	2.40	2.12	2.80	2.81	2.48

[a]Baseline assumes 6 percent increase in constant relative prices throughout the period, 5 percent real income (total expenditures) growth in all regions, and population growth as projected by the Central Bureau of Statistics.

Table 2.9. Projections of red meat and poultry consumption for Indonesia, 1988-95

Alternative Assumptions	Projected Average Annual Percentage Change in Total Consumption	
	Red Meat	Poultry
CARD/MOA Baseline[a]	5.15	3.40
Rise in Total Real Expenditure (10% vs. 5%)	8.48	6.62
Fall in Relative Red Meat Prices (3% vs. 6%)	7.05	3.42
Fall in Relative Poultry Prices (3% vs. 6%)	5.16	5.50
Fall in Relative Red Meat & Poultry Prices (3% vs. 6%)	7.08	5.54
Rise in Relative Red Meat Prices (3% vs. 6%)	3.26	3.36
Rise in Relative Poultry Prices (3% vs. 6%)	5.14	1.36
Rise in Relative Red Meat & Poultry Prices (3% vs. 6%)	3.26	1.34

[a]The CARD/MOA Baseline assumes 6 percent annual increase in all prices throughout the period, 5 percent annual real income (total expenditure) growth in all regions, and population growth as projected by the Central Bureau of Statistics.

Table 2.10. Projections of food consumption for Indonesia under alternative regional income growth scenarios, 1988-95

	Projected Annual Percentage Change			
Alternative Assumptions	Rice	Cereals	Poultry	Sugar
CARD/MOA Baseline[a]	2.06	6.91	3.40	4.06
Faster Income Growth in Off-Java (10% vs. 5%)	2.52	8.95	4.58	5.72
Slower Income Growth in Off-Java (2% vs. 5%)	1.68	5.67	2.64	3.04
Faster Income Growth in Urban Java (10% vs. 5%)	2.29	8.67	4.60	5.10
Faster Income Growth in Java (10% vs. 5%)	2.67	10.67	5.44	6.29
Slower Income Growth in Java (2% vs. 5%)	1.52	4.51	2.12	2.70

[a]The CARD/MOA Baseline assumes 6 percent annual increase in all prices throughout the period, 5 percent annual real income (total expenditure) growth in all regions, and population growth as projected by the Central Bureau of Statistics.

CHAPTER 3. A NATIONAL FOOD CROP POLICY MODEL FOR INDONESIA

From the implementation of the New Order government's first five-year development plan (Repelita I) in 1969 until the mid-1980s, the overriding objective of Indonesian food policy was to increase rice production in order to be self-sufficient, at a relatively high level of consumption, in the nation's basic staple food. The goal of rice self-sufficiency was pursued through a centrally directed program of production and area targets, subsidized distribution of inputs with extension services, investments in irrigation and marketing infrastructure, and a remunerative floor price to farmers. With the achievement of rice self-sufficiency in 1985, the focus of Indonesia's food policy was broadened to include the promotion of secondary food crop production. But the basic mechanism of centrally directed supply targets and input distribution remained as the means to encourage diversification of the food crop sector.

Today, Indonesia is pursuing economic reforms directed at moving away from an administered economy to one more responsive to domestic and international market forces. At the national level for the agricultural sector, these reforms suggest a reduction in agricultural input subsidies, a relaxation of commodity production targets, and a better integration of the agricultural sector both with international commodity markets and with other sectors of the economy. This liberalization of the agricultural economy will occur against the backdrop of two conflicting sectoral realities. First, rice self-sufficiency, still Indonesia's preeminent food policy objective, is very tenuous and must be pursued vigorously if domestic production is to keep pace with even a slowing growth in future domestic consumption. And second, rising Indonesian incomes are changing the structure of consumer demand and creating different food crop requirements. Increased production of livestock products has raised the derived demand for secondary crops used as animal feeds. More broadly, although agriculture's share of GDP was halved during the 1970s and 1980s to about 25 percent in 1988, the sector still remains the largest source of employment for unskilled labor, providing income for more than half of the population. Continued growth in the agricultural sector during the 1990s, therefore, is necessary to help absorb Indonesia's ever-increasing labor force and to promote a stable transition to an industrialized economy.

What is needed by Indonesia's food policymakers and policy analysts at this time are flexible analytical tools to provide guidance in managing the transition of the agricultural economy to a more market-oriented structure. To be useful in this regard, a set of planning tools is required to explicitly, and consistently, take into account the intercommodity and intersectoral effects on the food sector of economic interventions and their removal. In what follows, a simulation model of Indonesia's food crop sector is introduced and described. The simulation uses a demand system to model consumption and an area and productivity (yield) model to determine food crop supply. Through a link to national income formation, developments in the food crop sector are linked simultaneously to the determination of national income. In addition, the model includes a component that determines feed demand directly from developments in the livestock sector.

Model Specification

The national model is built on a spreadsheet format (Lotus 1-2-3) and is in a framework that easily accommodates changes in behavioral parameter estimates and in other economic behavior assumptions. This feature of flexibility is incorporated, in part, to reflect Indonesia's rich accumulation of applied econometric research on commodity and input markets and the consequent range of parameter estimates available (Ellis 1988). It is not unusual for econometric estimation models with differing structures, specifications, and underlying data sources to generate different behavioral parameters. The problem for policy analysts and policymakers is to discern what reliable projections can be made when undertaking certain courses of action from a wide range of behavioral parameter estimates. Flexibility of analytical tools is key in such an environment. The spreadsheet format also facilitates updating of the model's projection base year.

The present version of the National Food Crop Policy Model (NFCPM) for Indonesia is a price-exogenous adaptation of a multicommodity, multisector, real-price driven economic simulation model developed by Altemeier, Tabor, and Daris (1989) that can be used to make projections of supply and demand balances for important food crops in Indonesia. Demand for eight food crops--rice, wheat, corn, cassava, soybeans, mungbeans, peanuts, and sugar--is estimated as a function of private expenditures and real food crop prices. Agricultural commodity supply is also modeled for eight food crops (wheat is not grown in Indonesia, but rice is separated into dryland and wetland production) and is defined as the product of area harvested and yield per hectare. Area harvested is estimated as a function of current or previous period crop prices (depending on crop-specific characteristics) and previous period area harvested. Crop yields are derived from a profit-maximizing relationship and are specified as a function of output and input prices. Supply available from production is adjusted for intermediate uses (seed, waste, feed, and industrial uses) and human consumption to determine a domestic market deficit or surplus. Market deficits or surpluses are closed by trade and/or changes in stock levels.

The model is simultaneous in that agricultural sector income is linked to the determination of private consumption expenditures, which in turn drive staple food demand. The value of food crop sector income is endogenously calculated by the model as the value of food crop sector product at wholesale prices less expenditures on fertilizer. Food crop sector income is added to product from other sectors of the economy to give total gross domestic product (GDP), which then determines private consumption expenditures. Figure 3.1 is a flowchart of the model.

The national model, in its present form, supports the analysis of agricultural price and trade policy. In addition to policy analytic capabilities, the model, by allowing the user to make projections, also provides a framework to monitor and anticipate developments in the food crop sector. The model's organization, in the form of a food balance sheet, allows the user to project future supply, demand (including intermediate uses), and market balances for important food crops. Projections of these variables, together with other information, can form the basis for regular production of food crop sector situation and outlook reports. Production of such reports would provide policymakers and planners with vital information as policies and programs in the food crop sector are formulated, implemented, and monitored.

Supply Component

Crop production components in the model are for wetland rice, dryland rice, soybeans, corn, cassava, peanuts, mungbeans, and sugar. Farmers are assumed to follow a two-stage production decision-making process. In the first stage, they choose which commodity to produce by allocating their land to various crops. In the second stage, farmers apply variable factors of production such as labor and fertilizer to determine a yield per hectare for the chosen commodity. For each commodity, then, domestic production (X_{si}) is defined as the product of area (A_i) and yield (Y_i) (see Appendix D for variable definitions):

$$\ln X_{si} = \ln Y_i + \ln A_i. \tag{3.1}$$

Area allocated to food crops production is a function of real own-crop prices, real prices of other land-competing crops, and previous period area achievements. The area allocation process is thus modeled to behave like a Nerlovian adjustment process. The typical form of the area-response equation used is with a single-period lagged expectation as follows:

$$\ln A_{it} = a_{it} + \sum_{j=1}^{m} b_{ij} \cdot \ln P_{j(t-1)} + c_i \cdot \ln A_{i(t-1)}. \tag{3.2}$$

Whether current or one-period lagged prices are used as a proxy for expected price depends upon when in the calendar year the main planting time occurs and the duration of the crop cycle. For example, the main rice planting period is October and November with the main harvest in April, so lagged prices are used in the rice equations. The main corn planting period is September/October with the main harvest in January, so lagged prices are used in the corn equation as well. Equations for longer duration crops such as sugarcane and cassava employ lagged prices also. Soybeans, on the other hand, have a growing time of only three months and are harvested continuously throughout the year. Current period prices are therefore used for soybeans. The lagged area variable is highly correlated with government area targets and must be interpreted accordingly. Finally, the intercepts are functions of time and shift according to exogenous nonprice factors such as public investments in new irrigation systems and rehabilitation.

Yields per hectare are defined as a function of output price (p), input prices (q) for variable inputs labor and fertilizer, and time:

$$\ln Y_{it} = y_{it} + d_i \cdot \ln p_{it} + \sum_{j=1}^{n} e_{ij} \cdot \ln q_{jt}. \tag{3.3}$$

The yield elasticities are derived from a profit function approach modeling the crop productivity relationship. Under the assumption of profit maximization, farmers apply labor and fertilizer to maximize profits. This second stage of the production process is thus modeled as the yield that results per hectare if farmers, having already allocated their lands to various commodities, maximize profits. The inclusion of a time dependent intercept, y_{it}, in the yield equations allows explicit treatment of exogenous efficiency gains that can result from, for example, dissemination of new technology and enhanced human capital.

Factor demands per hectare are also defined as a linear function of input and output prices and time:

$$\ln R_{ijt} = r_{ijt} + \sum_{k=1}^{n} u_{ik} \cdot \ln q_{jkt} + n_{ij} \cdot \ln p_{it}. \tag{3.4}$$

The factor demand elasticities, like the yield elasticities, are derived from a profit function model. The inclusion of a time dependent intercept allows for the impact of behavioral changes in input use due to new technology and enhanced human capital. In the future, labor use per hectare is likely to fall for most crops as the mechanization of agricultural tasks spreads, but fertilizer use per hectare is likely to increase due to exogenous factors such as the spread of rice intensification programs like SUPRA INSUS, promoting the diversification of fertilizer use.

Food Demand Component

Food crop demand per capita is modeled as a linear function of own and other staple foods prices and an endogenously determined estimate of real per capita total expenditures:

$$\ln X_{dit} = x_{it} + f_i \cdot \ln \hat{TEXPC}_t + \sum_{j=1}^{m} g_{ij} \cdot \ln p_{jt}. \tag{3.5}$$

Elasticity values are derived under the assumption of a subutility maximizing, two-stage (staple foods and other goods) expenditure budgeting. That is, in the parameter estimations, household consumption is assumed to be determined first by allocating the budget between staple foods and other goods, then allocating to different food commodities within the staple food category. Private consumption expenditures per capita, which together with prices drive demand, are defined as a function of an endogenously defined estimate of per capita GDP:

$$\ln \hat{TEXPC}_t = a_0 + a_1 (\ln \hat{GDP}_t - \ln POP_t). \tag{3.6}$$

Feed Demand Component

In countries like Indonesia, where longtime series of quarterly livestock data are not available, two alternative approaches can be employed to estimate the total use of food crops as animal feeds by the livestock sector. One approach considers the demand for feed derived from consumption of livestock products. The other uses historical and expected growth trends in the animal population to indicate likely future growth of feed requirements. The latter approach is more feasible and likely to be more appropriate when changes in supply factors determine the rate of growth of the livestock sector (at least in the short run), as appears to be the case in Indonesia. This is the one adopted in the national model.

In the animal population approach, numbers of animals in each feed-using livestock group need to be determined for a base year. Since the livestock portion of the national model is intended to project the use of food crops as animal feeds, only population groups that utilize food crops in their feed rations need to be included. Field observations and general knowledge indicate that dairy cattle, hogs, poultry, and ducks are the main users of food crops in their feed rations. Because feeding practices vary by type of operation, the animal populations must also be disaggregated by husbandry method. Hogs are disaggregated into modern and small-holder operations. Small-holder hog producers are divided further into confined and extensive operations. Chickens are split into commercial layers, broilers, and village chickens called ayam kampung. Village chicken producers are divided further into intensive and extensive enterprises. Duck and dairy cattle operations are fairly homogeneous throughout Indonesia and are not disaggregated further.

To make projections of feed use by animal populations, projections of numbers of animals in the livestock sector must be made first. There are numerous approaches to projecting animal populations. Rates of population increase can be estimated on the basis of past trends. For example, simple linear trends are estimated from annual time series data. Linear trends are less appropriate in cases where there is considerable government intervention or other exogenous factors affecting the development of the particular livestock industry. For example, the government is currently conducting a major campaign to import improved dairy cattle breeding stock in an attempt to attain self-sufficiency in milk production. Improved hog breeding stock is being imported as well to shorten fattening periods. Further, the commercial poultry industry in the 1990s is likely to be driven more by how quickly export opportunities can be exploited than by past trends in population growth. In these cases, discerning future population growth requires judgment about the impact of factors apart from past trends in population growth.

Numbers of animals must be translated into feed requirements and ultimately into feed use. The current version of the livestock model includes estimated annual per animal feed requirements, expressed in kilograms, for each of the disaggregated livestock groups included in the model (see Table 3.9). The composition of the gross feed ration figures is also included in the model. Once future animal populations have been determined, projections of feed use can be made simply by multiplying the feed requirement and composition figures by the appropriate animal population figure. This type of projection model framework is implemented easily in a spreadsheet format. By developing the model on a computer spreadsheet, alternative animal population growth rates, per animal feed use requirements, and feed ration compositions can be incorporated easily into the projection analysis.

National Income Component

In the income component of the model, the economy is partitioned into three sectors. National income (GDP) is defined as the sum of income generated in (1) the food crop sector, (2) the mining and defense sectors, and (3) the other products and services sectors:

$$GDP = GDP_1 + GDP_2 + GDP_3. \tag{3.7}$$

The food crop sector income is derived directly from the supply side of the model. Food crop sector product is defined as the value of food crop sector output valued at real wholesale crop prices less the cost of fertilizer:

$$GDP_1 = (\sum_{i=1}^{m} p_i \cdot X_{si} - q_j \cdot \sum_{i=1}^{m} r_{ij} \cdot A_i) \cdot CORR \ (j = \text{fertilizer}). \tag{3.8}$$

The endogenously determined sector income thus includes all wages, rents, profits, and interest generated from farm production minus the cost of chemical fertilizers, the predominant agricultural input used from outside the sector. The parameter CORR is a constant correction factor that accounts for differences between the endogenously determined food crop sector product and figures from national statistical yearbooks. This parameter reflects, largely, the value of horticultural production not accounted for in the model but included as part of food crop sector income in the national accounts. National product generated from the estate sector and livestock production is not included in the CORR parameter.

The "mining and quarrying" and "administrative services and defense" subsectors from the national accounts are added together to comprise a sector labeled mining and defense. The value of extractive earnings and thus mining sector output depends very heavily on world petroleum prices, as do the budget funds available to undertake administrative and defense activities. For this reason, the GDP from this sector is defined exogenously in the model.

The difference between total GDP and the sum of food crop sector product and the mining and defense sector product equals, by definition, the value of goods and services produced in other sectors of the economy. This other or residual sector comprises mainly industrial, services, and estates production. In a real price model with an exogenous inflation rate, price changes in the food crop sector must be offset by price movements for products in this other goods sector. The price relationship between the food crop and other sectors affects the real growth potential in either sector. Further, since many products in the other sector can be traded, the real exchange rate will have an impact on nonfood crop production. Production in the industrial, estates, and services sector, then, is defined as a function of exogenous technical change, relative intersectoral prices, and the real Rp/US$ exchange rate:

$$GDP_3 = G_t + h \cdot \ln (\hat{P}_z / \hat{P}_f) + \epsilon (\ln EXC + \ln \hat{P}_z). \qquad (3.9)$$

Intersectoral, real price relationships are formed by determining nonfood crop prices as a function of an index of food crop prices. The food crop price index is defined as a share-weighted sum of commodity prices:

$$\ln \hat{p}_f = \sum_{j=1}^{m} \hat{W}_j \cdot \ln(p_{j(t)}/p_{j(\text{base year})}), \qquad (3.10)$$

with $\hat{W}(j)$ being

$$\hat{W}j = X_{dj} \cdot P_j/FEXP_{(t-1)}. \qquad (3.10a)$$

The aggregate price index, P_a, is defined as the geometric index of food and nonfood prices:

$$\ln(\hat{P}_a) = S_f \ln \hat{P}_f + (1 - S_f) \ln \hat{P}_z,$$

$$\hat{S}_f = [FEXP/TEXP]_{(t-1)}.$$

Because this is a real-price model, $P_a = 1$ by definition, so it is possible to derive nonfood prices from food prices and the relative expenditure shares:

$$\ln \hat{P}_z = \hat{V} \cdot \ln \hat{P}_f,$$

which is determined by the relative share of food expenditures (FEXP) in total expenditures:

$$\hat{V} = -S_f/(1 - \hat{S}_f).$$

Model Closure

In a model like this one, either agricultural output prices or trade quantities can be set exogenously, in addition to the exchange rate, input prices, population growth rates, and mining/defense sector output. In the present version of the model, trade or stocks are allowed to adjust and clear commodity markets. Agricultural production and beginning stocks provide total domestic supplies. Human consumption and intermediate uses (feed, seed, waste, and other nonfood uses) are subtracted to yield a domestic market surplus or deficit, which is closed by trade or stock adjustments. If there are limits on imports or stock adjustments, both can be allowed to adjust. More generally, market closure assumptions can be altered to reflect changes in trade/stocks policies or in economic behavior of the private trade.

The nature of the adjustment process varies by commodity and reflects crop-specific trade policies. Wheat imports, although controlled by the Indonesian Food Logistics Agency (BULOG), are physically conducted by private flour mills that hold stocks for inventory purposes. These levels historically have been about 25 percent of annual flour production. Thus the baseline holds stocks at 25 percent of flour production and endogenizes wheat imports. Rice trade policy during the Repelita V period is likely to be one of non-entry into world markets as long as domestic stock levels are within BULOG's operational bounds, between 1 million and 2.5 million metric tons. When stock levels fall out of this range, BULOG will either import or export until stocks are back within an acceptable range. Thus rice stocks adjust first to domestic surplus or deficit, and trade occurs only if a stock bound is reached. Sugar production is now consistently below domestic consumption, so imports are necessary every year. Stock levels are quite high at present and are assumed to be reduced by 25,000 metric tons per year over the Fifth Plan period to keep imports at a reasonable level. After the stock adjustment, imports clear the sugar market. Stock levels are far less significant for other crops, and trade is assumed to clear all other markets.

The intermediate use of agricultural commodities is modeled very simply. Feed use is determined as the derived demand from those livestock population projections described above. Other nonfood uses (waste and industrial use) are fixed percentages of annual production. The use rates employed in the model are those found in the food balance sheets published by the Central Bureau of Statistics (CBS). Seed use is determined by average per hectare application rates and cultivated area. Per-hectare seed application rates are taken from the annual cost of production surveys published by CBS.

Behavioral Parameters and Technical Assumptions

This model is in constant elasticity form. The current version of the model uses 1988 as the base year for projections. The food crop sector is defined as production and use of rice, wheat, corn, cassava, soybeans, peanuts, and mungbeans measured at wholesale prices. Sugar is also included in the model because it is an important competitor for land use with food crops, but it is not included in the calculation of sector product. Agricultural area parameters are based on time-series analysis of area and price developments. Yield and factor demand elasticities are based on econometric estimation of profit function relations using farm survey data from 1986. The estimation of supply parameters is discussed more fully in Altemeier et al. (1988). Commodity demand parameters are derived from an Almost Ideal Demand System (AIDS) model estimated from 17 years of expenditure and wholesale price data. The demand results are reported in Tabor et al. (1989). Nonfood crop sector output is defined as total GDP less petroleum/defense sector output and agricultural sector output. A time series of (deflated) exchange rates and the consumer price indexes reported by CBS were used in the estimation of nonfood crop GDP parameters. The elasticity values used in the present model are reported in Table 3.1.

Demand parameters for wheat are taken from Meyers (1988) and added to the demand system without making adjustments to the other parameters. Therefore, own- and cross-price elasticities of demand in the current version of the model do not sum to zero. Because the model is based on real prices, the homogeneity condition still holds. The lack of symmetry in commodity demand should not significantly affect model simulation results or the usefulness of the model, especially if it is used properly as an analytical tool rather than as a basis for forecasting.

Although 1988 was considered a normal year for food crop production, adjustments were made to some of the intercepts in the area equations. The drought of 1987 affected corn, soybean, mungbean, and peanut production quite severely. Because of the impact of the one-period lagged area variable in the area equations, it was judged that the "below trend" cultivated areas in 1987 unduly raised equation intercepts for 1988, the model's projection base year. In order to be in line with the estimated trend growth in harvested area during the 1980s, the 1987 lagged area figure was raised somewhat in the calculation of 1988 area intercepts for corn, soybeans, mungbeans, and peanuts. This change made the 1988 intercept values for these crops lower than they would have been without adjustment.

In the livestock component of the model, animal population data are taken from the Directorate General of Livestock (DGL) of the Ministry of Agriculture. The DGL has been conducting a census of livestock animal populations since 1970. Data describing feeding practices were derived from field surveys undertaken by CAER and CARD research staff and from secondary data sources. The derivation of animal requirement and feed ration composition figures is described in detail in Rachmat, Waluyo, and Sudaryanto (1990).

Policy Applications

The use of the model as a tool for policy analysis and to assess possible developments in the food crop sector is best illustrated with examples.

Baseline Simulation

As discussed above, Indonesia has embarked on a program of economic liberalization. For a model like this one to be useful for analyzing economic policy reform during the Repelita V period, it is necessary to simulate a baseline or benchmark from which the potential impacts of policy changes can be judged. For a price-exogenous model, this involves making assumptions about domestic commodity prices during Repelita V. Given the nature of issues likely to confront Indonesia's policymakers during the Fifth Plan, an appropriate baseline would be one that reflects the consequences of a continuation of past agricultural policies and programs--a high level of input subsidies, and insulation of domestic markets from international markets--in the pursuit of planned self-sufficiency objectives and public investments in the food crop sector.

The Fifth Economic Development Plan calls for food self-sufficiency between 1989 and 1993. The price-endogenous model built by Altemeier et al. (1988) was used to simulate the domestic food crop prices resulting from efforts to achieve overall self-sufficiency during Repelita V. The food self-sufficiency objective was represented in the model as a series of "feasible" target self-sufficiency ratios (domestic production over total demand) for individual food crops if stated policy goals were actively pursued. The trade ratios actually used represent a more modest set of goals than those found in the Fifth Plan. Setting trade ratios exogenously and simulating for prices allows movements of domestic prices different from world prices and thus provides a continuing degree of protection for Indonesia's farmers. Exogenous growth rates in crop areas and yields were also set relative to the likely impact of planned levels of public investment, extension activities to be carried out over the period, and historical trends. The exogenous area and yield growth assumptions used in this price simulation exercise are found in Table 3.2.

The resulting annual changes in real commodity prices for the Repelita V period are reported in Table 3.3. The price results indicate that steady increases in real food crop prices are necessary to achieve a somewhat more modest set of self-sufficiency targets than those implied in the Fifth Plan despite the very substantial run-up in prices that occurred during the 1986 to 1988 period. In particular, rice prices must continue to rise if the tenuous self-sufficiency in Indonesia's basic staple food is to be maintained. Assuming a constant real exchange rate, comparison of the domestic price projections with results from price projections found in the most recent CARD/FAPRI world agricultural outlook indicates that Indonesia's domestic prices could be increasing in the face of falling real agricultural commodity prices in world markets. If so, Indonesia would have to continue insulating its domestic markets from international markets during the Repelita V period to achieve targeted production levels.

The next step in the baseline exercise is to insert the price projections from the Altemeier et al. (1988) model into the price-exogenous model described above to simulate a baseline for the Repelita V period. In theory, this should result in the same production and consumption levels as the price-endogenous model does. However, the price-endogenous model employs a somewhat different parameter base, does not include wheat, and specifies cultivated area as a function of current real prices only. The exogenous growth rates in cultivated area and yield used in the baseline simulation are those used in the price simulation summarized in Table 3.2. Population is projected to grow by 2.1 percent each year during the period. Real rural wages, fertilizer prices, and real exchange rates are assumed to remain unchanged after 1989. Finally, the petroleum and defense sector and the exogenous component of the industrial and services sector GDP equation are assumed to grow at 5 percent per year.

The results of the baseline simulation along with base year data (1988) are summarized in Table 3.4. With real prices of all food commodities rising, and some help from slightly declining real wheat prices, production growth in the sector is fairly high, and Repelita V trade targets are attained or exceeded. For example, Indonesia becomes a net exporter of corn and is essentially self-sufficient in peanuts and mungbeans by the end of the plan period; the high level of cassava exports is maintained to meet Indonesia's European Community (EC) quota; rice production stays in balance with rice consumption and imports are unnecessary. The sugar balance deteriorates as specified, with production levels falling to about 75 percent of domestic consumption.

What is disconcerting in the model results is that real price increases in food commodities constrain growth in overall GDP. The Indonesian Government's targeted GDP real growth rate of 5 percent per year (average) per year is not attained over the period. Furthermore, the targeted annual growth rate of 10 percent for the industrial and services sector is not even close to being reached. As long as Indonesia continues to pursue a high priced agriculture, high growth rates in other sectors of the economy could be difficult to achieve. This result points to a possible inconsistency between agricultural production targets and the government's goal of attaining employment growth through industrial growth.

Alternative Food Crop Price Scenario Simulations

This baseline simulation suggests that high agricultural commodity prices are necessary to achieve even a more modest set of agricultural production targets than those implied by Repelita V. Results from the macro component of the model further suggest that high agricultural prices restrict attainment of policy goals in other sectors of the economy. Therefore, a logical application of the model is a simulation of the implications of different agricultural commodity prices during the Fifth Plan period. Two scenarios are implemented. The first is a policy of no real price increases for food crops after 1989. The second consists of dropping all barriers to food crops trade after 1989, thus allowing world prices to determine domestic prices. World agricultural commodity market price projections from CARD/FAPRI models, FAO, and the World Bank are used in the second simulation. The results from the two simulations are summarized in Tables 3.5 and 3.6.

The constant real price simulation indicates a deterioration in agricultural trade position. Imports of rice, corn, soybeans, peanuts, and sugar increase significantly over the plan period. Because of exogenous yield and area increases, food crop sector GDP and farm incomes grow at more than 3 percent per year during Repelita V. The performance of the nonagricultural sectors improves over the baseline scenario although overall GDP growth remains about the same because higher industrial growth is offset by lower food crop sector growth.

The world price scenario results are quite interesting. Production of highly protected crops such as soybeans, peanuts, and sugarcane falls dramatically. On the other hand, performance of cassava, a crop whose price had been somewhat below prevailing world levels, is very strong. Although real output price growth is lower than in the baseline scenario, rice also does very well as a result of favorable relative price movements. Rice production benefits at the expense of sugar and soybeans, and in fact Indonesia is exporting sizable quantities by the end of Repelita V. Corn and cassava benefit also from the cross-effects of lower sugar and soybean prices, as well as from lower peanut and mungbean prices.

Under the world price scenario, the performance of the industrial and services sector is very strong, and overall GDP grows at slightly greater than 5 percent a year. The agricultural price index falls quite substantially, unleashing productive capacity in industry. A major drawback of a world price policy like the one simulated is the short-lived decline in farm income that occurs in the first year of implementation. Although incomes do recover by 1993, the short-run decrease in farm income resulting from such a policy change would make the world price scenario somewhat difficult to implement in practice because it might appear to farm groups that the government had stopped supporting rice production. But various measures, such as allowing rice prices to remain above world prices for one or two years, would cushion this short-run impact considerably. What is crucial to note, however, is the importance of the intercommodity effects of price policy changes and the implication that a liberalization of agricultural trade must be sectorwide rather than crop-specific for desired outcomes, such as trend self-sufficiency in rice and increased corn production, to occur. From a methodological standpoint, this result shows the necessity of using multimarket analytical tools, such as the National Food Crop Policy Model, when examining food price policy questions.

Food Crop Diversification Scenario

The diversification of food crop production is an often discussed objective of Indonesian food policy. Diversification is viewed as the key to raising the incomes of Indonesia's myriad small farmers, particularly in upland areas, and to unleashing the country's latent potential in agribusiness. However, food policy analysis suggests that the diversification objective must be pursued cautiously, with careful attention paid to underlying comparative advantage and judicious use made of available policy instruments if Indonesia is to benefit fully from diversification of food crop production.

The national model can be used to illustrate the potential pitfalls of using certain policy instruments to pursue food crop diversification. A scenario consisting of raising prices of corn and soybeans relative to rice prices and enforcing area targets for corn and soybeans is simulated over the Repelita V period (1989-93). Specifically, real corn and soybean prices are assumed to increase by 2 percent each year, and real rice and other crop prices are assumed to be constant during the simulation period. Area targets are implemented by increasing the exogenous growth in cropped areas by .5 percent and .25 percent per year for corn and soybeans (trend area growth for soybeans is already very high in the baseline), respectively, relative to baseline assumptions. Exogenous rice area growth is reduced to accommodate implementation of the corn and soybean targets. All other price and area assumptions are the same as in the baseline simulation.

The consequences of this diversification scenario are predictable and summarized in Table 3.7. Annual corn and soybean production growth averages about 6 percent through Repelita V. The trade balances improve dramatically as well--corn exports reach 750 thousand tons in 1993 and annual soybean imports fall by over 100 thousand tons during Repelita V despite strong demand growth. However, the cost of this strong corn and soybean growth is a loss of rice self-sufficiency. Indonesia imports about 2.5 million tons of rice in 1993 and production growth falls off to less than 2 percent a year. This result indicates that there is a tradeoff between rice self-sufficiency and diversification if it is pursued through a strategy of differential output pricing and area targets.

The simulation results suggest that the objective of food crop diversification is best pursued with policy instruments that are not biased against rice production. Such a strategy would include dissemination of productivity-enhancing technologies such as higher yielding soybean seeds; public investment in infrastructure that enhances cropping intensities such as water pumps to allow additional cultivation of corn in the late dry season; and price changes resulting from shifts in underlying demand such as the derived demand for corn as an animal feed resulting from increased production of chicken meat and eggs. This, in turn, suggests that diversification of Indonesia's food crop sector would be a logical and natural outgrowth of continued funding of agricultural research, investments in rural infrastructure, economic liberalization that allows unfettered development of private agribusiness (for example, a repeal of KEPPRES 50--the presidential decree limiting the size of poultry operations), and growth in per capita incomes.

Livestock Projection Model Results

Indonesia's livestock sector is poised to grow rapidly during Repelita V. Overall economic growth is now projected to exceed 5 percent per year through the mid-1990s (Asian Development Bank 1990), which should have the effect of raising domestic demand for livestock products, particularly for chicken meat and eggs. In addition, with the deregulation of trade in livestock products, domestic production could surge if export markets are developed. Rapid growth of the livestock sector, in turn, would have important implications for the food crop sector through the feed linkage. Most food crops consumed in Indonesia are utilized in some form by Indonesia's livestock sector, although often as byproducts (like rice bran and wheat pollards), and therefore they are not in direct competition with consumption by humans. However, use of corn and soybeans by the livestock sector is in a form that competes directly with human food supplies.

For the baseline projection exercise, animal population growth estimates from the Directorate General of Livestock are used. Historical populations of the major feed-using livestock groups for 1986-88 and projections for 1989-93 are found in Table 3.8. The feed requirements per animal and the composition of feed rations, in addition to other assumptions, are shown in Table 3.9.

The resulting projections of aggregate feed use for several major feedstuffs are listed in Table 3.10. The baseline figures in Table 3.10 suggest rapid growth in the use of corn and soybeans (utilized as soymeal in feed concentrate), with growth rates of more than 8 percent a year in the use of each commodity as an animal feed. During Repelita V, according to the projections, feed use of corn and soybeans would amount to roughly 15 and 40 percent of domestic production, respectively. The growth in feed use of corn and soybeans is projected to outpace the growth in production of the two commodities during Repelita V and is projected to be about 3.4 percent per year for corn and 3.3 percent per year for soybeans in the baseline (see Table 3.4). This result suggests increased import levels of soybeans and a smaller exportable surplus of corn.

Table 3.11 indicates the underlying structure of feed demand in Indonesia and reveals that the commercial poultry industry is the primary user of corn and soybeans as feedstuffs. Roughly 60 percent of corn feed demand and 80 percent of soymeal demand comes from the commercial poultry industry. Since commercial poultry is expected to grow most rapidly during Repelita V, the relative shares of use for corn and soymeal are projected to increase over the period. The dominance of the commercial poultry industry in the use of feedstuffs and the generally high level of use by the livestock sector suggests that when policymakers assess future food crop needs, they should be attentive to developments in the poultry industry. Since future feed demand is likely to be met increasingly by imports, at least for soybeans, trade policies should be deregulated to ensure timely provision of supplies to the livestock sector at competitive costs. In addition, given Indonesia's comparative advantage as a corn, poultry, and hog producer (Kasryno et al. 1989), increased domestic corn production to meet domestic feed needs would be an economically efficient way of adding value to a primary agricultural commodity and promoting agribusiness development.

The importance of the poultry sector in determining future feed demand levels is shown in Table 3.12. In the table, the implications for use of corn and soymeal as animal feeds under alternative livestock development scenarios are shown. A doubling of the growth rate (to 20 percent) of the commercial poultry industry (including both layers and broilers) and an intensification of village-layer operations (to reach 20 percent of the total village chicken population) each produce annual growth in the feed use of corn and soymeal of well over 10 percent. The two scenarios generate feed demand of more than 300 hundred thousand tons of corn and 100 thousand tons of soymeal greater than the baseline scenario by 1993. Faster growth of modern hogs (to a 10 percent annual rate) or accelerated modernization of dairy herds would have a relatively small incremental impact on demand for these crops. Although the modern hog industry's feed rations are fairly corn intensive, the animal population base is relatively very small and thus more rapid growth does not have a significant impact on overall corn feed use. Dairy operations in Indonesia use very small amounts of corn and soybeans in their feed rations, utilizing mainly byproducts and fodder. This behavior could change in the future as dairy production is intensified, but still likely would not result in a large increase in overall feed use because dairy herds are relatively small.

Conclusion

These applications of the National Food Crop Policy Model for Indonesia illustrate the usefulness of addressing policy issues with flexible analytical tools. The model provides a broad range of relevant outputs that policymakers can use in assessing the impact of changes in economic policy on the food crop sector. The multimarket nature of the model, in particular, allows for the incorporation into food policy analysis of the important cross-price effects that characterize Indonesian agriculture. The impact on other sectors of the economy is also accounted for through its macro linkages.

Analytical model building for food policy analysis is a dynamic process. The national model is structured in such a way that the underlying data base can be changed easily to reflect new information and changing economic structures. In an economy that is changing rapidly due to economic growth and market deregulation, as is the case in Indonesia, the feature of flexibility is of utmost importance in keeping analytical tools for policy analysis and monitoring current and reliable.

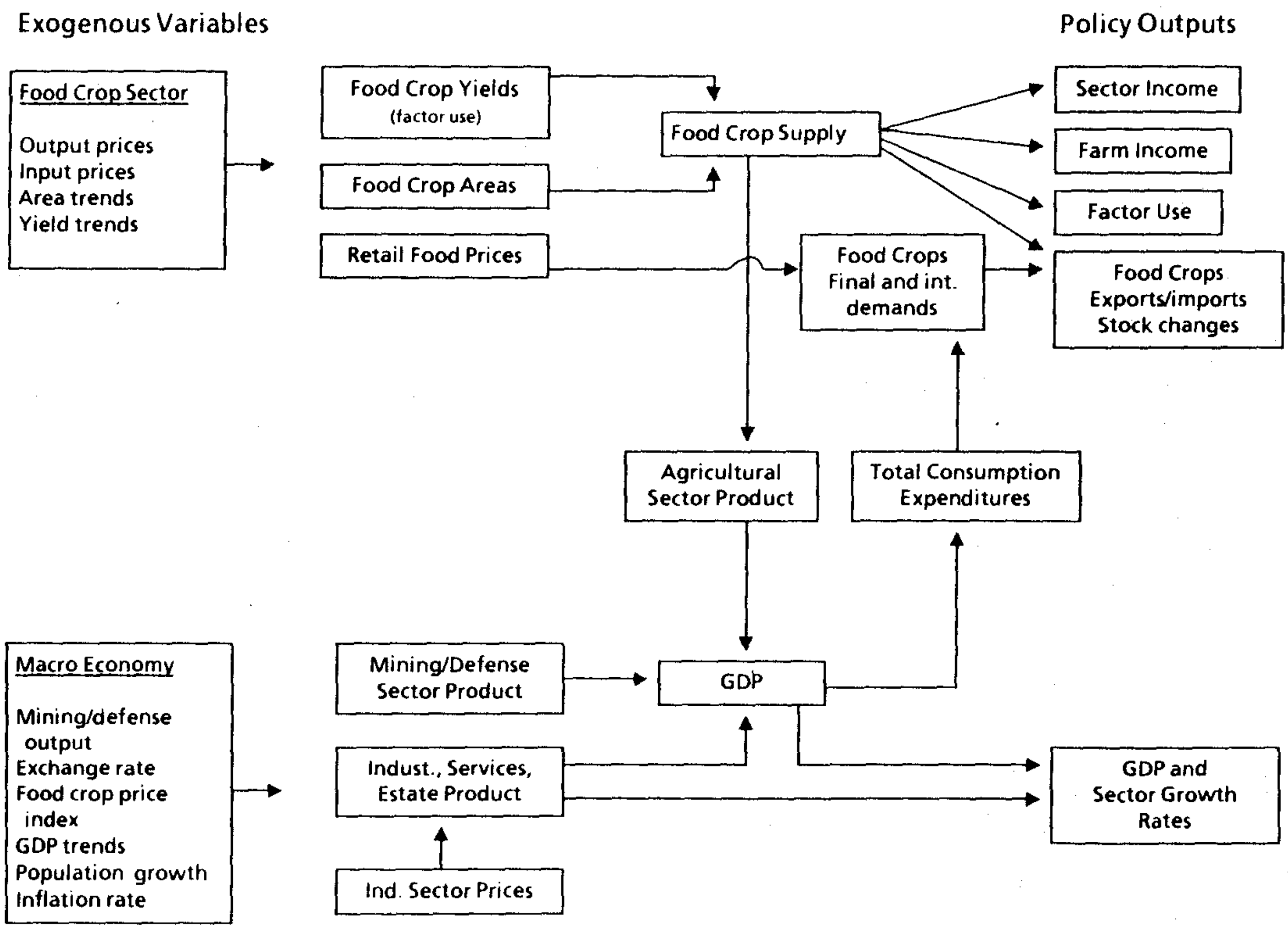

Figure 3.1. Structure of the national food crop policy model

Table 3.1. Behavioral assumptions and parameters for national crops model

Area Response Elasticities

Price/Crop	Wet Rice	Dry Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar
Rice	0.157	0.475	0.000	0.000	0.000	0.000	0.000	-0.162
Corn	-0.079	0.000	0.687	-0.030	-0.157	-0.050	-0.674	0.000
Cassava	-0.004	0.000	-0.042	0.093	-0.149	0.000	0.000	0.000
Soybeans	-0.019	-0.006	-0.203	-0.069	1.106	-0.279	0.000	0.000
Peanuts	0.000	0.000	0.000	-0.121	-0.115	0.597	0.000	0.000
Mungbeans	0.000	-0.113	0.000	0.000	0.000	0.000	0.655	0.000
Sugar	-0.155	-0.259	-0.160	0.000	-0.059	0.000	-0.098	0.200
Lagged area	0.000	0.000	0.680	0.870	0.290	0.770	0.750	0.500

Factor Elasticities

Per hectare Yields wrt	Wet Rice	Dry Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar
Commodity price	0.30	0.29	0.60	0.27	0.19	0.09	0.19	0.30
Fertilizer price	-0.03	-0.01	-0.07	-0.05	-0.04	-0.01	-0.01	0.00
Wage rate	-0.27	-0.21	-0.53	-0.22	-0.15	-0.08	-0.18	0.00

Fertilizer demand wrt	All Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar
Commodity price	0.63	0.96	1.28	1.09	0.26	0.52	
Fertilizer price	-0.47	-0.17	-0.66	-0.84	-0.74	-0.40	
Wage rate	-0.16	-0.78	-0.62	-0.25	0.48	-0.12	

Labor demand wrt	All Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar
Commodity price	1.58	2.46	1.59	0.88	0.52	1.67	
Fertilizer price	0.00	-0.26	0.06	-0.05	0.07	-0.05	
Wage rate	-1.57	-2.20	-1.65	-0.83	-0.59	-1.61	

Demand Parameters

Price/Commodity	Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar	Wheat
Rice	-0.1591	0.3865	0.4288	0.2139	0.4125	0.4055	0.1571	0.2000
Corn	0.0451	-0.2608	0.0556	0.0274	-0.1189	-0.1695	-0.0806	0.0500
Cassava	0.0356	0.0395	-0.3904	-0.0289	-0.1024	0.0904	-0.0005	0.0200
Soybeans	0.0230	0.0253	-0.0374	-0.7786	0.4828	-0.1391	0.2256	0.0200
Peanuts	0.0247	-0.0610	-0.0740	0.2690	-0.7379	0.4026	-0.0196	0.0000
Mungbeans	0.0069	-0.0245	0.0184	-0.0219	0.1136	-0.6799	0.0100	0.0000
Sugar	0.0239	-0.1049	-0.0010	0.3190	0.0497	0.0899	-0.2919	0.0200
Wheat	0.0300	0.0000	0.0200	0.0200	0.0000	0.0000	0.0200	-0.3800
Expenditure	0.2940	0.3880	0.2610	0.4580	0.6420	0.6140	0.5190	0.4750

Table 3.2. Assumptions for Repelita V baseline

Exogenous Growth Parameters for	Wet Rice	Dry Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar
Area (%/yr)	0.75	0.50	0.00	-0.50	2.50	0.50	0.50	1.00
Yield (%/yr)	1.00	0.50	1.25	1.75	0.70	0.50	0.50	1.00
	(all rice)							
Trade Ratios (%)	100		100	110	80	100	100	75

Table 3.3. Projected real price change under baseline

	Real price growth (%/yr)				
Commodity/Year	1989	1990	1991	1992	1993
Rice	2.5	2.1	2.0	2.0	1.9
Corn	1.2	1.3	1.2	1.2	1.2
Cassava	0.9	1.3	1.7	2.2	2.6
Soybeans	0.3	0.4	0.3	0.3	0.4
Peanuts	1.5	1.4	1.4	1.3	1.3
Mungbeans	0.1	0.1	0.2	0.2	0.0
Sugar	0.0	0.5	0.5	0.5	0.5
Wheat	1.0	-1.0	-1.0	-1.0	-1.0

Table 3.4. Summary: Repelita V baseline simulation, 1988-93

Outcomes	Year	Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar	Total
Real wholesale price	1988	404	186	107	664	1429	970	621	
Real farmgate price		203	159	63	630	619	735		
(1986 Rp/kg)	1989	414	189	108	666	1450	971	621	
		208	161	64	632	573	736		
	1993	448	200	117	675	1530	976	634	
		225	171	69	641	663	740		
Growth rate 1988-93 (%/year)		2.10	1.42	1.74	0.34	1.38	0.12	0.40	
Cultivated area (1000 ha)	1988	10090	3203	1268	1143	582	316	328	16930
	1989	10443	3277	1292	1174	604	342	320	17451
	1993	10852	3608	1291	1324	715	388	309	18487
Growth rate 1988-93 (%/year)		1.47	2.41	0.36	2.98	4.19	4.13	-1.15	1.78
Yields (mt/ha)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	3.03	2.26	13.31	1.14	1.01	0.79	6.09	
Growth rate 1988-93 (%/year)		1.50	1.94	2.10	0.67	0.60	0.49	1.00	
Net exports (1000 mt)	1988	-35	-33	2475	-373	-28	0	-256	
	1989	-275	-66	2539	-381	-25	7	-164	
	1993	0	24	2518	-532	5	-6	-475	

	1988	1989	1993	Growth Rate 1988-93 (%/year)
Food crop sector GDP (billions 1986 Rp.)	19,682	20,966	25,281	5.13
Farm income (billions 1986 Rp.)	8,468	8,941	11,124	5.61
Other sector GDP (billions 1986 Rp.)	64,845	66,852	78,609	3.92
Overall GDP (billions 1986 Rp.)	105,561	109,903	130,736	4.37

Table 3.5. Summary: Constant real price simulation, 1988-93

Outcomes	Year	Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar	Total
Real wholesale price	1988	404	186	107	664	1429	970	621	
Real farmgate price		203	159	63	630	619	735		
(1986 Rp/kg)	1989	414	189	108	666	1450	971	621	
		208	161	64	632	573	736		
	1993	414	189	108	666	1450	971	621	
		208	161	64	632	628	736		
Growth rate 1988-93 (%/year)		0.50	0.42	0.18	0.06	0.30	0.02	0.00	
Cultivated area (1000 ha)	1988	10090	3203	1268	1143	582	316	328	16930
	1989	10443	3277	1292	1174	604	342	320	17452
	1993	10789	3466	1297	1345	679	418	313	18307
Growth rate 1988-93 (%/year)		1.35	1.59	0.46	3.31	3.13	5.72	-0.96	1.58
Yields (mt/ha)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	2.96	2.19	13.04	1.14	1.01	0.79	6.09	
Growth rate 1988-93 (%/year)		1.05	1.23	1.67	0.61	0.50	0.47	1.00	
Net exports (1000 mt)	1988	-35	-33	2475	-373	-28	0	-256	
	1989	-275	-76	2540	-381	-25	8	-164	
	1993	-1122	-411	2311	-486	-42	28	-453	

	1988	1989	1993	Growth Rate 1988-93 (%/year)
Food crop sector GDP (billions 1986 Rp.)	19,682	20,962	25,853	3.03
Farm income (billions 1986 Rp.)	8,468	8,938	9,948	3.27
Other sector GDP (billions 1986 Rp.)	64,845	66,855	81,649	4.72
Overall GDP (billions 1986 Rp.)	105,561	109,903	131,348	4.47

Table 3.6. Summary: World price simulation, 1988-93

Outcomes	Year	Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar	Total
Real wholesale price	1988	404	186	107	664	1429	970	621	
Real farmgate price		203	159	63	630	619	735		
(1986 Rp/kg)	1989	414	189	108	666	1450	971	621	
		208	161	64	632	573	736		
	1993	426	179	124	370	581	508	484	
		213	153	73	351	252	385		
Growth rate 1988-93 (%/year)		1.05	-0.79	2.79	-11.05	-16.47	-12.15	-4.87	
Cultivated area (1000 ha)	1988	10090	3203	1268	1143	582	316	328	16930
	1989	10443	3277	1292	1174	604	342	320	17451
	1993	11504	4633	2043	619	233	159	284	19476
Growth rate 1988-93 (%/year)		2.66	7.66	10.02	-11.55	-16.70	-12.89	-2.81	2.84
Yields (mt/ha)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.85	2.08	12.16	1.11	0.99	0.77	5.85	
	1993	2.98	2.12	13.53	1.02	0.93	0.70	6.09	
Growth rate 1988-93 (%/year)		1.12	0.61	2.43	-1.61	-1.14	-1.93	1.00	
Net exports (1000 mt)	1988	-35	-33	2475	-373	-28	0	-256	
	1989	-275	-66	2539	-381	-25	7	-164	
	1993	2279	756	10275	-1484	-721	-223	-567	

	1988	1989	1993	Growth Rate 1988-93 (%/year)
Food crop sector GDP (billions 1986 Rp.)	19,682	20,966	24,478	4.46
Farm income (billions 1986 Rp.)	8,468	8,941	10,411	4.22
Other sector GDP (billions 1986 Rp.)	64,845	66,852	83,616	5.22
Overall GDP (billions 1986 Rp.)	105,561	109,903	134,939	5.03

Table 3.7. Summary: Diversification simulation, 1988-93

Outcomes	Year	Rice	Corn	Cassava	Soybeans	Peanuts	Mung-beans	Sugar	Total
Real wholesale price	1988	404	186	107	664	1429	970	621	
Real farmgate price		203	159	63	630	619	735		
(1986 Rp/kg)	1989	404	190	108	677	1450	971	621	
		203	162	64	642	573	736		
	1993	404	206	117	733	1530	976	634	
		203	176	69	695	663	740		
Growth rate 1988-93 (%/year)		0.00	2.00	1.74	2.00	1.38	0.12	0.40	
Cultivated area (1000 ha)	1988	10090	3203	1268	1143	582	316	328	16930
	1989	10420	3293	1292	1197	601	340	320	17464
	1993	10528	3806	1276	1504	677	372	316	18479
Growth rate 1988-93 (%/year)		0.85	3.51	0.13	5.64	3.06	3.28	-0.73	1.77
Yields (mt/ha)	1988	2.81	2.06	12.00	1.10	0.98	0.77	5.79	
	1989	2.83	2.09	12.16	1.11	0.99	0.77	5.85	
	1993	2.94	2.30	13.31	1.16	1.01	0.79	6.09	
Growth rate 1988-93 (%/year)		0.88	2.29	2.10	0.98	0.60	0.49	1.00	
Net exports (1000 mt)	1988	-35	-33	2475	-373	-28	0	-256	
	1989	-275	30	2642	-336	-27	9	-164	
	1993	-2478	746	2836	-230	-28	-2	-442	

	1988	1989	1993	Growth Rate 1988-93 (%/year)
Food crop sector GDP (billions 1986 Rp.)	19,682	20,515	22,951	3.12
Farm income (billions 1986 Rp.)	8,468	8,741	10,172	3.74
Other sector GDP (billions 1986 Rp.)	64,845	67,404	81,731	4.74
Overall GDP (billions 1986 Rp.)	105,561	110,005	131,527	4.50

Table 3.8. Livestock population projections, Repelita V baseline

Livestock Group	1986	1987	1988	1989	1990	1991	1992	1993
Dairy Cattle								
Calves	31,080	32,480	36,400	40,284	44,582	49,339	54,604	60,430
Young cows	47,730	49,880	55,900	61,865	68,465	75,771	83,855	92,803
Adults	143,190	149,640	167,700	185,594	205,396	227,312	251,566	278,409
Total	222,000	232,000	260,000	287,742	318,444	352,422	390,025	431,641
Hogs (Modern)								
Piglets	111,888	114,102	116,352	119,610	122,959	126,402	129,941	133,579
Young hogs	174,048	177,492	180,992	186,060	191,269	196,625	202,130	207,790
Hogs	335,664	342,306	349,056	358,830	368,877	379,205	389,823	400,738
Total	621,600	633,900	646,400	664,499	683,105	702,232	721,895	742,108
Hogs (Smallholder)								
Confined	3,636,360	3,708,315	3,781,440	3,887,320	3,996,165	4,108,058	4,223,084	4,341,330
Extensive	1,398,600	1,426,275	1,454,400	1,495,123	1,536,987	1,580,022	1,624,263	1,669,742
Total	5,594,400	5,705,100	5,817,600	5,980,493	6,147,947	6,320,089	6,497,052	6,678,969
Poultry								
Commercial Layers								
Growers	19,344,500	16,484,000	21,230,500	21,230,500	21,230,500	21,230,500	21,230,500	21,230,500
Layers	19,344,500	16,484,000	21,230,500	21,230,500	21,230,500	21,230,500	21,230,500	21,230,500
Eggs (tons)	250,700	259,000	275,200	294,189	314,488	336,187	359,384	384,182
Total Layers	38,689,000	32,968,000	42,461,000	42,461,000	42,461,000	42,461,000	42,461,000	42,461,000
Broilers	173,795,000	218,183,000	235,661,000	258,755,778	284,113,844	311,957,001	342,528,787	376,096,608
Village								
Intensive	16,299,100	16,840,500	17,399,900	18,235,095	19,110,380	20,027,678	20,989,007	21,996,479
Extensive	146,691,900	151,564,500	156,599,100	164,115,857	171,993,418	180,249,102	188,901,059	197,968,310
Total	162,991,000	168,405,000	173,999,000	182,350,952	191,103,798	200,276,780	209,890,065	219,964,789
Ducks								
Growers	13,501,000	13,013,000	12,589,000	13,079,452	13,589,550	14,119,543	14,670,205	15,242,343
Layers	13,501,000	13,013,000	12,589,000	13,079,452	13,589,550	14,119,543	14,670,205	15,242,343
Eggs (tons)	117,000	121,800	117,900	121,673	125,566	129,584	133,731	138,011
Total Ducks	27,002,000	26,025,000	25,177,000	26,158,903	27,179,100	28,239,085	29,340,409	30,484,686

Table 3.9. Livestock feed demand projection assumptions

Livestock Group	Population Composition (%)	Feed Req. (kg/ animal yr)	Population Growth (%/yr)	Feed Composition (%) Corn	Rice Bran	Rice	Soymeal	Gaplek	Wheat Pollards	Other
Dairy Cattle			10.67							
Calves	14	402			0.6		0.60		0.05	0.29
Young cows	21.5	913			0.63				0.05	0.32
Adults	64.5	2519		0.08	0.6				0.05	0.27
Hogs (Modern)			2.8							
Piglets	18	33		0.48	0.15		0.22			0.15
Young hogs	28	219		0.47	0.37		0.03			0.13
Hogs	54	657		0.45	0.47		0.02			0.06
Hogs (Smallholder)			2.8							
Confined	65	400		0.05	0.46		0.01		0.02	0.46
Extensive	25									
Poultry										
Commercial layers			9.8							
Growers	50	19		0.38	0.23		0.19			0.2
Layers	50	40		0.4	0.23		0.15			0.22
Eggs		3	6.9	0.4	0.23		0.15			0.22
Broilers	100	2.3	9.8	0.54	0.09		0.18		0.02	0.17
Village			4.8							
Intensive	10	22.5		0.24	0.53		0.1			0.13
Extensive	90	4.75		0.05	0.7	0.1				0.15
Ducks			3.9							
Ducklings	50	9		0.05	0.7	0.05		0.01		0.01
Layers	50									
Eggs		4.7	3.2	0.05	0.7	0.05		0.01		0.01

Table 3.10. Repelita V baseline projection for feed use by the livestock sector

Feedstuff	1986	1987	1988	1989	1990	1991	1992	1993	Annual Growth (%) Repelita V
Corn	888	963	1015	1083	1156	1235	1320	1411	8.6
Rice bran	2315	2395	2468	2588	2715	2850	2993	3146	6.3
Rice	97	101	102	107	111	116	121	126	5.4
Soymeal	243	267	283	304	326	350	376	405	9.4
Gaplek	55	57	55	57	59	61	63	65	4.3
Wheat pollards	58	61	65	70	75	80	86	93	11.1
Other	1243	1292	1342	1407	1477	1551	1631	1716	6.5

Table 3.11. Structure of corn feed and soymeal demand, Repelita V baseline

	1986		1987		1988		1989		1990		1991		1992		1993	
Corn Feed Demand	(000)	%[a]	(000)	%	(000)	%	(000)	%	(000)	%	(000)	%	(000)	%	(000)	%
Dairy cattle	29	0.03	30	0.03	34	0.03	37	0.03	41	0.04	46	0.04	51	0.04	56	0.04
Hogs (modern)	119	0.13	121	0.13	124	0.12	127	0.12	131	0.11	134	0.11	138	0.10	142	0.10
Hogs (smallholder)	73	0.08	74	0.08	76	0.07	78	0.07	80	0.07	82	0.07	84	0.06	87	0.06
Commercial poultry	517	0.58	582	0.60	623	0.61	674	0.62	730	0.63	791	0.64	857	0.65	928	0.66
Village poultry	123	0.14	127	0.13	131	0.13	137	0.13	144	0.12	151	0.12	158	0.12	166	0.12
Ducks	27	0.03	29	0.03	28	0.03	29	0.03	30	0.03	30	0.02	31	0.02	32	0.02
Total	888		963		1015		1083		1156		1235		1320		1411	
Soymeal Demand																
Dairy cattle	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00
Hogs (modern)	6	0.03	6	0.02	7	0.02	7	0.02	7	0.02	7	0.02	7	0.02	8	0.02
Hogs (smallholder)	15	0.06	15	0.06	15	0.05	16	0.05	16	0.05	16	0.05	17	0.04	17	0.04
Commercial poultry	185	0.76	207	0.78	221	0.78	240	0.79	259	0.79	280	0.80	304	0.81	329	0.81
Village poultry	37	0.15	38	0.14	39	0.14	41	0.14	43	0.13	45	0.13	47	0.13	49	0.12
Ducks	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	243		267		283		304		326		350		376		405	

[a] Proportion of total demand (year to left).

Table 3.12. Feed use under alternative livestock growth scenarios

Simulation	Feed Use (1000 tons) 1989	1990	1991	1992	1993	Annual Growth (%) Repelita V
Corn Feed Use during Repelita V						
Baseline	1083	1156	1235	1320	1411	8.6
20 percent commercial poultry growth	1125	1249	1391	1552	1736	14.4
10 percent modern hog growth	1092	1175	1265	1363	1468	9.7
Poultry and hogs	1134	1268	1421	1595	1793	15.3
Accelerated dairy modernization	1122	1199	1283	1373	1470	9.7
Accelerated intens. *ayam buras*	1224	1304	1390	1482	1582	11.7
Soymeal Feed Use during Repelita V						
Baseline	304	326	350	376	405	9.4
20 percent commercial poultry growth	319	360	407	460	521	16.5
10 percent modern hog growth	304	327	352	379	408	9.6
Poultry and hogs	319	361	408	462	524	16.7
Accelerated dairy modernization	335	361	389	419	452	12.4
Accelerated intens. *ayam buras*	365	391	418	447	479	14.1

CHAPTER 4. A REGIONAL POLICY ANALYTICAL SYSTEM FOR FOOD CROPS

As Indonesia advances into the 1990s, agricultural policy is in a period of transition. In addition to sustaining self-sufficiency in rice production, Indonesian policymakers and analysts are focusing on diversifying food crop production and increasing overall economic efficiency. The fertilizer subsidy, which was (arguably) responsible for achieving rapid rice production growth in the past, is now believed to encourage farmers to use inputs at inefficient levels. Cognizant of the externalities involved in such an input subsidy policy, the Indonesian government has begun to phase out the subsidy program. At the same time, alternative strategies to shift agricultural policy from one of external controls to a more market-oriented approach are being contemplated and in some cases implemented. These strategies range from an increased emphasis on deregulation of the agroprocessing sector to shifting more of palawija and sugarcane production to off-Java areas. These reforms, among others, are partly motivated by the large burden on the government budget to maintain existing policies, and partly by the adjustments necessitated by Indonesia's transition to a middle-income economy.

These policy changes have a significant impact on the economy at the national level. However, evaluating the impact of changing agricultural policies on the economy only at the national level masks the sharp regional differences that characterize the Indonesian agricultural economy. The production systems and cropping and consumption patterns vary widely among regions and imply that national agricultural policies will have differential regional impacts.

Even though Indonesia comprises more than 13,000 islands, 90 percent of the population is concentrated on Java, Sumatra, Sulawesi, and Bali. It is estimated that approximately 60 percent of the total population lives on Java, which is only 7 percent of the total area of Indonesia, making it one of the most densely populated regions in the world. The importance of Java for the food economy is well known and documented elsewhere (Timmer 1987). Table 4.1 presents the historical and projected growth rates for wetland rice, corn, and cassava in selected provinces on Java and the outer islands. The table shows that the growth rate of area harvested for wetland paddy in Java has declined in recent years and is projected to decline further in the 1990s. The annual growth rate in area harvested for wetland paddy in Indonesia was around 1.7 percent during 1975-80 and 2.4 percent during 1980-85; the annual growth is projected to be less than 0.5 percent during the next decade.

The leveling off of area growth in wetland rice cultivation coupled with the shift to off-Java areas has several implications for Indonesia's efforts to maintain rice self-sufficiency. One possibility for easing the burden on Java's land is to shift some of the area devoted to other crops such as sugarcane to off-Java regions to allow for increased rice cultivation on Java. To best apply this policy requires knowledge about regional comparative advantage and relative efficiency of production systems among various provinces and regions. For instance, there is clear evidence that Indonesia would be better off growing rice and palawija in sugarcane areas on Java (see Chapter 3). Efforts are already under way to move sugarcane production off of Java.

The regional shift in food production is more transparent for palawija crops. The demand for these crops is expected to increase indirectly through the increased demand for meat products due to changes in income, which in turn would induce a higher derived demand for feedstuffs, particularly corn. The direct human consumption of palawija crops is also expected to increase in the future (see Chapter 2). As indicated in Table 4.1, the cultivated area for corn in the Java provinces is expected to remain constant over the next decade while it is expected to grow at a rapid rate in off-Java regions, particularly in Lampung. The regional shift in cassava production is even more stark as the cassava area harvested on Java has been declining steadily since the 1970s and is expected to continue this downward trend during the next decade. Just the reverse is expected in off-Java areas. From a food policy perspective, such shifts in regional production have important implications for public investment. Appropriate plans must be made to develop transport, market information, processing, and other infrastructure in order to ensure distribution of foodstuffs from production centers on outer islands to consumption centers, mainly on Java.

This discussion suggests that areas off Java will become increasingly important for meeting the overall need of food production. A regional analytical focus is therefore the appropriate means of assessing important issues such as relative comparative advantages that arise in this context. This regional perspective for policy analysis would increase the capacity of regional and national agencies to undertake agricultural planning at both the national and regional levels, including regional-level situation and outlook evaluations, and serve as an effective tool with which to create region-specific extension policies.

The reasons, then, for constructing a regional information and analytical system in Indonesia are

1. To develop a consistent set of data that provides information about various policy options by themselves or through descriptive analysis

2. To study the regional diversity in production, economic efficiency, and trends in commodity demand and supply
3. To understand the importance of individual regions in promoting national economic growth and development and meeting national food requirements and vice versa
4. To promote the decentralization process by providing better information to and analytical capability in provincial governments
5. To study market price linkages which provide a better understanding of the impact of various price policy measures at different levels of the marketing chain

The work described below was intended to initiate the construction of a regional food policy analytical system for Indonesia. The study has approached regional modeling on a pilot basis and implicitly assumes a "top-to-bottom" implementation approach. As such, the purpose of the analytical system is to evaluate the regional impact of policies emanating from the central agency. This approach reflects the limited role played by the regional offices (KANWIL) in implementing agricultural policies.

The Regional Food Crops Analytical System for South Sulawesi

The regional modeling was carried out for South Sulawesi as a prototype model. Agriculture is the most important sector in South Sulawesi, contributing 45.18 percent of gross regional (South Sulawesi) domestic product at 1983 market prices. South Sulawesi's share of the gross national domestic agricultural product was only about 4.77 percent. In 1987, the food crop sector constituted 27.54 percent and livestock and fisheries constituted 13.26 percent of the gross regional domestic product at 1983 market prices. Although the actual levels of food crop production are not very high when compared with other provinces in

Java, South Sulawesi's contribution to the national market in marketed surplus is quite substantial. This creates a niche for South Sulawesi in the national food economy. South Sulawesi ranks second to East Java in its contribution to the national rice buffer stock, and it is estimated that nearly half, or in some cases more than half, of the production of palawija crops is exported to Java (Tabor et al. 1988).

With respect to trade, South Sulawesi exported a total of US $39 million worth of agricultural commodities during 1987, about 14 percent of the total value of exports from the province. Since 1985, South Sulawesi has been a net exporter in the balance of trade. Fertilizer and wheat are the important commodities imported directly into South Sulawesi from other countries.

Conceptual Framework of the Policy Model

To understand fully the implications of changing agricultural policies and their impact on regional growth, it is necessary to take into account intercommodity, intersectoral, and various agricultural market price linkages in a consistent framework. Since the emphasis of the CARD/MOA study is on developing models that are flexible and pragmatic, a price exogenous, multicommodity, multimarket approach was adopted. The approach is pragmatic in the sense that it can be put into operation easily through personal computers and put into use by policymakers with minimal computer training. It is flexible in the sense that the model can be adapted to a wide range of intraprovincial behavioral parameters or to other provinces with different sets of parameters. It can also be used effectively in regions for which data are limited.

The approach is "partial" in the sense that no attempt is made to endogenize the macro component of the regional economy; that is, regional income generation is treated exogenously. By assuming prices as given (exogenous), a structural model consisting of supply, food demand, and other end uses for each commodity is maintained, and the model is closed through assimilation of market deficit or surplus. It should be noted that the analytical system implicitly treats the province as a separate economy with specific linkages to the CARD/MOA National Food Crops Policy Model (NFCPM; see Chapter 3). However, the scope is limited to food crops. No attempt is made to include other sectors.

Model Structure

From a modeling standpoint, it is essential to identify a set of key commodities whose production, consumption, and prices have an important bearing on the local and national economy. This can be identified through different components of the Regional Food Crops Policy Model (RFCPM). The analytical framework for RFCPM comprises three components: (1) supply; (2) demand; and (3) price linkages. A schematic representation of the various components and their linkages is illustrated in Figure 4.1.

Supply Component

The production of various crops is represented by a set of behavioral equations for area harvested, yield per hectare, and the variable input demand system. Although they may not be derived explicitly from standard economic optimization models, these equations are behavioral in the sense that they respond to economic variables such as prices of outputs and inputs. The system of equations constituting the crop supply sector can be expressed as follows:

$$\ln AH_{it} = a_0(t) + \Sigma\, a_j \ln FP_{j\ t-1} + d_{i1} \ln AH_{i\ t-1}, \tag{4.1}$$

$$\ln YD_{it} = b_0(t) + b_1 \ln FP_t + b_2 \ln PF_t + b_3 \ln WR_t, \tag{4.2}$$

$$\ln X_{it} = c_0(t) + c_1 \ln FP_t + c_2 \ln PF_t + c_3 \ln WR_t, \tag{4.3}$$

$$\ln CP_t = \ln AH + \ln YD, \tag{4.4}$$

where

$\ln AH$ = logarithm of area harvested of the ith crop;

$\ln YD$ = logarithm of yield per hectare of the ith crop;

$\ln CP$ = logarithm of total crop production;

$\ln FP$ = logarithm of real farm/producer price of output;

$\ln PF$ = logarithm of real price of fertilizer;

$\ln WR$ = logarithm of real wage rate;

$\ln X$ = logarithm of input use, namely fertilizer and hired labor;

t = time or trend variable to reflect technical change or structural change as the case may be.

The above specifications are in constant elasticity form; the parameters required are in the form of elasticities, namely area response, input price, and output supply elasticities.

Area harvested in equation (4.1) hypothesizes a partial adjustment process and adaptive price expectations. The partial adjustment process is accounted for by including a lagged dependent variable in the equation. Inclusion of the previous period area harvested also reflects the fixity of land resources for dynamic adjustments. The lagged real prices depict the adaptive expectation process in farmers' decision making. Finally, the effect of technology and other factors are represented in the form of intercept shifts.

The variable input system comprises fertilizer and hired labor demand equations; thus the model is multimarket in this context. The yield per hectare and demand for fertilizer and labor are defined as a function of the output price, fertilizer price, and wage rate, all in real terms. Again, the effect of changing technology is absorbed through intercept shifts.

Demand Component

The demand component for food crops consists of a number of intermediate uses and final food demand availability. Beside waste, stocks, and trade, the intermediate uses are classified as feed, industry/food processing, and seed. These intermediate uses are modeled simply as a fixed percentage of crop supply or production.

The availability for food consumption is modeled as a log linear food demand system. Accordingly, the logarithm of the demand for food consumption is expressed as a function of the logarithm of real prices and the logarithm of real per capita food expenditure,

$$\ln FD_{it} = d_0 + d_j \ln WP_{jt} + e_i \ln FEXP_t, \qquad (4.5)$$

where

$\ln FD$ = logarithm of food availability/demand;

$\ln WP$ = logarithm of wholesale real prices;

$\ln FEXP$ = logarithm of real food expenditure;

d_j is a set of price elasticities;

and e_i is a set of expenditure elasticities.

Price Linkages

In order to evaluate the impact of policies emanating from the central government, the regional or provincial model has to be linked to the national model. While this could be done in a number of ways, the spatial market integration approach is followed here. The main feature of this approach is that a central market serves as the primary determinant of the market price in the regional market, and this effect is represented in the form of a distributed lag structure. The model is expressed in terms of percentage change as

$$\ln P_t - \ln P_{t-1} = a + b\,(\ln P_{t-1} - \ln P^*_{t-1}) + c\,(\ln P^*_t - \ln P^*_{t-1}) + d \ln P^*_{t-1} + eX, \tag{4.6}$$

where

$\ln P_t$ = logarithm of the price at the local market at time t;

$\ln P^*_t$ = logarithm of the price at the reference or central market at time t;

X = set of seasonal, regional, or other environmental variables that influences the local market;

a,b,c,d, and e are parameters.

Equation (4.6) explains changes in prices at the local market as due to changes in the reference price for the same period, lagged spatial price margins, lagged reference market price, and local market characteristics.

Since the NFCPM uses Jakarta wholesale prices as a determining variable, it provides a logical way of linking the provincial wholesale market with the national (Jakarta) market. To keep the analysis simple, the wholesale market in Ujung Pandang is assumed to be integrated with the Jakarta wholesale market in a fixed percentage, here 90 percent. In other words, 90 percent of the change in Jakarta wholesale prices is transmitted to the Ujung Pandang wholesale market. Since the regional and national models are based on annual price movements, the constant percentage relationship seems reasonable.

Another potential linkage is through the regional personal consumption expenditure. Since regional growth and development affect the national economy, the regional personal expenditure could be linked to the national personal consumption expenditure. This is not implemented in the model.

Market Closure

For all the commodities considered in this study, the market is cleared by net interprovincial trade, using a positive value to denote net exports, and a negative value to denote net imports. Since the data on interprovincial trade are almost nonexistent, this approach not only provides an easy way of overcoming the data problems, but also sheds some light on the extent of trade between provinces.

Inventory demand and other components of demand are treated either as exogeneous or by a simple rule. For instance, for rice and corn, the ending stocks were treated as a fixed percentage of total food demand (assumed to be 10 percent). For other crops, some stocks were treated as exogenous and others as constant.

Behavioral Parameters and Technical Assumptions

The analytical framework encompasses supply of wetland rice (sawah), dryland rice (ladang), corn, cassava, soybeans, peanuts, and mungbeans crops, allowing for substitution possibilities among different competing crops. The demand system consists of rice, corn, cassava, soybeans, peanuts, mungbeans, and sugar.

The elasticities used for area response equations are presented in Table 4.2. Most of these estimates are based on econometric estimation using South Sulawesi data from 1976 to 1988. In cases where the estimates were not satisfactory, the elasticities were derived based on (1) the results of the Java and off-Java area response elasticities reported in Rosegrant et al. (1987) and Tabor et al. (1988); (2) consistency of the estimates to the most recent data; and (3) subjective judgment about the relative magnitude of elasticities in South Sulawesi.

The yield and input demand system parameters used in this model are presented in Table 4.2. The parameters for rice and corn are based on the estimated elasticities for South Sulawesi using a restricted profit function approach (See Technical Papers 5 and 6). In a few cases, the parameters estimated from the restricted profit function were adjusted slightly to fit the more recent data and to account for differences existing among data sources. Because of data and information limitations, dryland paddy, peanuts, and mungbeans are modeled as simple trends for area yield per hectare and the variable input demand.

Due to the lack of region-specific conversion factors, estimates reported in the national food balance sheets were taken as a guideline and adjusted to conform to conditions in South Sulawesi. Care was taken to incorporate South Sulawesi conversion factors wherever information was available.

Since a two-step budgeting process was assumed in the demand component, it was necessary to estimate the per capita food expenditures first. These were calculated as a constant percentage of per capita real income. Based on South Sulawesi data from the 1987 household consumption (SUSENAS) survey, the real food expenditure was taken as 65 percent of the real per capita income. The demand parameters, namely own- and cross-price and income elasticities, were not directly available for South Sulawesi.

The few demand studies that have used SUSENAS survey data to estimate regional demand parameters have focused only on income or expenditure elasticities. Price elasticities, particularly cross-price elasticities at the provincial level, are not available. Hence, the available national aggregate estimates (Tabor et al. 1989) and estimates of demand parameters for urban and rural areas and/or on-Java and off-Java areas (both from the CARD/MOA study, Chapter 3, and from Rosegrant et al. 1987) were used and adjusted to fit the data for South Sulawesi. The demand parameters used for the South Sulawesi analytical system are reported in Table 4.2.

The farm to wholesale price linkage is represented as a simple markup, where the farm price is a fixed percentage of the wholesale price in Ujung Pandang. The retail price was also derived from the wholesale price using a combination of some constant markup and a fixed percentage of the wholesale price. This allowed for processing and marketing costs involved in transferring and transforming the commodities into consumer products. These relationships are important for determining the impact of agricultural price policy changes on supply and demand.

Before the model was put into use for projection, it was calibrated to base year data. Since 1987 was not a normal year, the supply side of the model was calibrated to 1986 data. With respect to the demand side, time series data were not available on a regional basis. However, regional per capita consumption figures could be derived from the SUSENAS survey data. The food availability demand was calibrated based on the per capita consumption figure derived from the 1987 SUSENAS survey, after adjusting upward to account for availability and underreporting.

Model Applications

This model provides an analytical tool with which to evaluate alternative policies and their impact at the regional level. The analytical system is conditioned on assumptions on future prices, exogenous growth in area, crop yields, and the regional economy. In order to demonstrate the analytical capabability of the model, a baseline scenario and two alternative policy scenarios are specified and discussed.

Baseline Simulation

In a typical simulation model, a most likely set of values of these variables is assumed to provide a benchmark for evaluation of policy alternatives. This baseline scenario reveals the effect of continuing the past or historic path of these exogenous variables under existing conditions. The provincial Repelita V projections and assumptions were used as guidelines for the baseline simulation presented in this regional analysis. Table 4.3 shows the assumptions made on the South Sulawesi economy. Population was assumed to grow from 1988 at a rate of 1.51 percent per year. Based on Repelita V goals, real gross regional domestic product (GRDP) was assumed to grow at the rate of 5 percent each year, and inflation was assumed to be 8 percent per year.

The baseline growth rates for area, crop yields, and prices are provided in Table 4.4. The growth rates for area and yield were based on South Sulawesi Repelita V targets. In some cases, the figures were adjusted to reflect current market conditions as well as the perceived feasibility of Repelita targets.

The real fertilizer price was assumed to grow at the rate of 1 percent per year, while the real wage rate was assumed to remain constant at the 1988 level. Table 4.4 shows that soybeans were targeted to show the greatest increase in area, to the extent of 3 percent per year. This reflects the attempt to increase soybean area under the crops intensification program known as BIMAS. Corn area was assumed to grow at the rate of 1 percent per year, while a modest growth of 1 percent or less per year was assumed for other crops. The highest yield growth rate was assumed for corn due to the potential in South Sulawesi to shift from the traditional white corn to the higher yielding yellow corn variety. Rice and cassava yields per hectare were assumed to grow respectively at 1.6 percent and 1.75 percent per year due to nonprice or external factors.

The growth rates for real crop prices shown in Table 4.4 are based on the price linkage mechanism described above. They are merely the result of the implied assumption made regarding price transmission: 90 percent integration of the provincial market with the national market (Jakarta) and the constant markup margin between wholesale and farm prices.

The results of the baseline simuation are summarized in Table 4.5. The results include net returns and total farm income (from food crops) for the province. Under the baseline scenario, soybeans and corn area are expected to increase respectively at rates of 5.06 percent and 2.34 percent per year. Among crop yields, corn shows the largest increase followed by cassava and rice. Overall fertilizer use for all food crops increases at an average rate of 5.71 percent per year; use on corn and soybeans is projected to increase by 7.97 percent and 7.29 percent per year, respectively.

As indicated earlier, South Sulawesi is unique in terms of providing a substantial marketable surplus in rice and palawija crops. The surplus figures in Table 4.5 show that nearly 1.1 million tons of rice would be made available during each year of the Repelita V period under the baseline assumptions. In 1988, the regional logistics agency, DOLOG, procured (approximately) only 200 thousand tons from South Sulawesi for its buffer stock operations. The remaining surplus was moved out of the province by private traders. The surplus figures also indicate that more than 300 thousand tons of corn will be available annually from South Sulawesi for interprovincial trading during the Repelita V period. Because of the external factors and strong price growth assumptions in the baseline, the net surpluses of both corn and soybeans are expected to increase at the rate of approximately 6.5 percent per year during the Repelita V period. These figures again indicate the extent of private trading between South Sulawesi and other provinces.

At the same time, the per capita availability of rice increases from 153 kg in 1988 to 174 kg in 1993, while the per capita availability of palawija crops shows only a marginal increase. Information on calorie and protein intake based on the availability figures is also available although, because of the differences existing between availability and consumption data, it is best to regard these nutrient intake figures as crude indicators.

In sum, the Repelita V scenario indicates that rice will continue to dominate the South Sulawesi food economy. Corn will also steadily improve, mostly through yield increases as more farmers shift to high yielding yellow varieties. Because of modest population growth, the increase in food crop production, in general, will augment the trade surplus figures, underscoring the importance of South Sulawesi in terms of providing surplus commodities to other regions. Furthermore, because of the potential for producing corn in South Sulawesi and the importance of corn as a feedstuff in poultry, shrimp, and hog operations, it may be economical and helpful to promote agribusiness development in this region and thus provide added value to the primary agricultural commodities.

Policy Applications

Two alternative price simulations were considered. The first simulation assumes an increase of real prices for corn and soybeans relative to rice. This simulation is consistent with a food crop diversification scenario because it provides price incentives to farmers to increase production of corn and soybeans. The second simulation assumes that nominal prices for all food crops increase at the same rate as inflation; that is, there is no relative real price increase.

The real price assumptions used in the food diversification simulation of NFCPM are implemented in the South Sulawesi policy model through the national/regional price linkage. Although the regional model can operate independently with its own price assumptions, the pan-territorial structure of agricultural policy in Indonesia suggests that it is more appropriate to evaluate policy alternatives through the national/regional price linkage.

Food Crop Diversification. According to this scenario, the real price of rice is kept constant and the area growth in rice cultivation is reduced by 0.25 percent from the baseline, as documented in Table 4.6. Both corn and soybeans prices are assumed to grow at the rate of 1.8 percent. All other assumptions are kept at the same level as in the baseline simulation.

Table 4.7 summarizes results for the food crop diversification scenario. As expected, the area harvested for corn increases more than for the baseline scenario. The area harvested in soybeans and corn increases at the rate of 5.16 percent and 3.8 percent per year, respectively. Yield increases are not substantial for soybeans. This suggests that even under a favorable price scenario, much of the increase in soybean production will occur through area growth, the added area coming at the expense of area in rice. The shift in production leads to lower trade surplus for rice compared to the baseline, and to a decline in the surplus steadily over the projection period at an average rate of 1.69 percent per year. Thus, artificially inducing diversification of food crop production through price policy instruments is shown to occur at the cost of support to the national rice self-sufficiency objective.

Constant Real Price Scenario. This scenario is based on an assumption of no changes in real prices for all food crops, as indicated in Table 4.8. The results for the constant real price scenario are summarized in Table 4.9. In real terms, the total farm income from rice cultivation declines from 6.24 percent in the baseline scenario to 3.49 percent in the constant real price scenario. The trade surplus of the region declines to 0.2 percent per year. Because of the importance of rice in South Sulawesi's income and employment generation, the reduction in rice production will have a severe impact on overall regional growth and development. This is reflected in the changes to total farm income and net revenue per hectare, as reported in Table 4.9. The annual rate of growth in net revenue per hectare for rice decreases from an annual rate of 4.37 percent in the baseline to 2.12 percent under the constant real price scenario.

Final Remarks

As Indonesia exhibits wide differences in production and consumption patterns among regions and because of the regional diversity and apparent shift in production to off-Java islands, there is a need for a regional perspective to Indonesia's agricultural policy analysis. For this purpose, Indonesian policymakers need an analytical tool that will be flexible and pragmatic. The CARD/MOA regional analytical framework was developed to satisfy such a need. The model is in constant elasticity form and is constructed as a Lotus spreadsheet so that it can be updated easily with new parameters or applied with minor changes to other regions. This kind of approach is particularly useful in places like Indonesia, where region-specific information is limited. Furthermore, the CARD/MOA regional analytical framework can also be used with other regional planning programs, such as "mapping," to evaluate the impact of region-specific agricultural programs. However, the analytical system is limited to evaluation of "what if" questions, rather than production of forecasts.

The type and sources of data for constructing a regional analytical system are presented in Appendix F. Indonesia has rich sources of secondary data. The general problem is that existing data are not consistent, nor are they free of biases introduced by being generated in various government agencies. The CARD/MOA regional modeling effort provided the opportunity to gather existing data and construct a consistent set of data for policy analysis. Some methods and procedures that can be effectively used to overcome certain type of limitations in the available price data are described in Technical Paper 8.

Other modifications and improvements in the South Sulawesi policy model are also possible. First, a more formal and sophisticated price linkage between the regional and national markets along the lines of spatial market analysis can be incorporated. Second, feed use conversion in the food balance sheets can also be modified based on the feed conversion factors reported in the NFCPM. Finally, the income and employment generation of the regional economy can be endogenized.

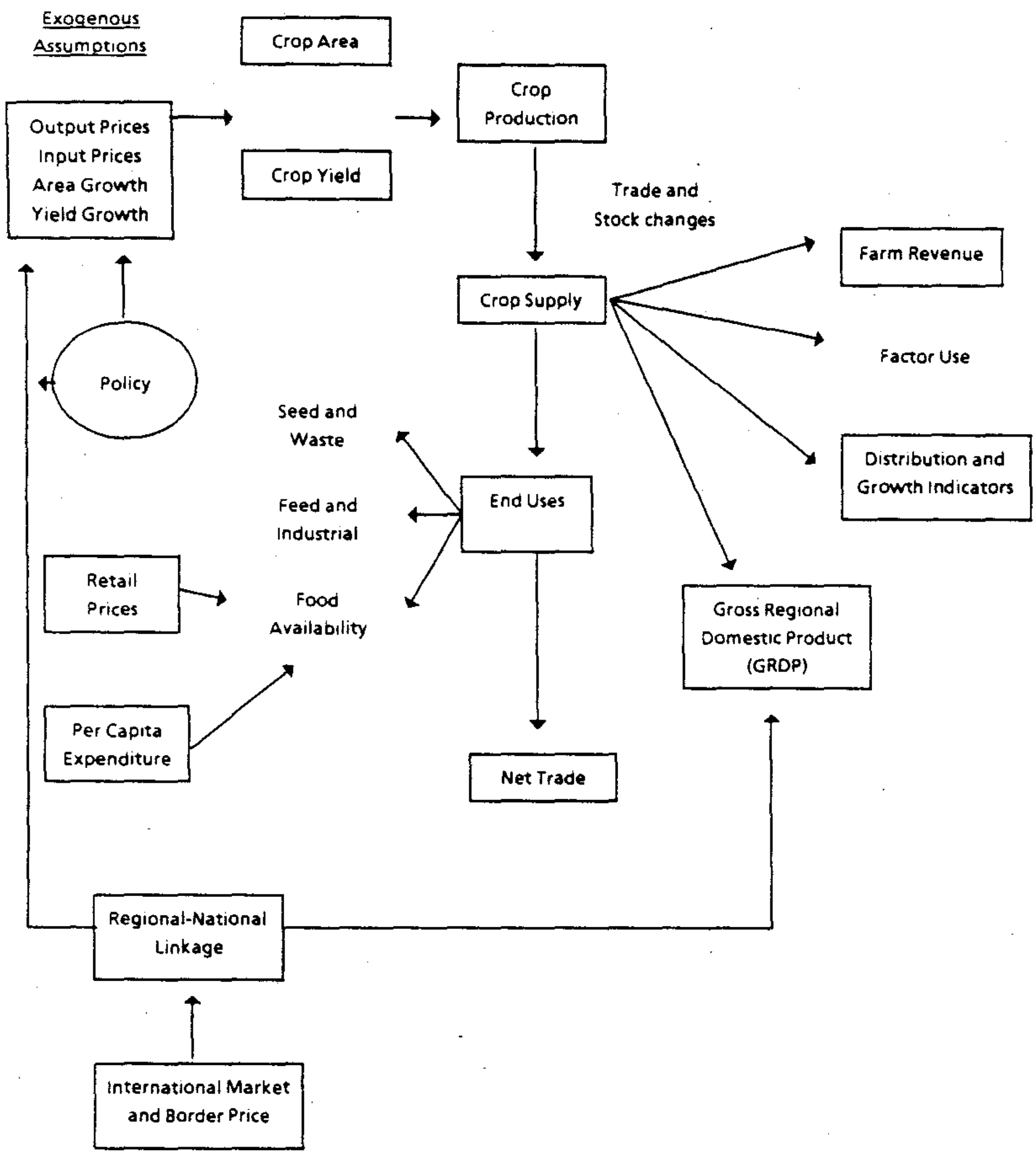

Figure 4.1. Structure of the regional policy system

Table 4.1. Trends in area harvested for various food crops

Year/Region	Wetland Paddy	Corn	Cassava
		Percent Change	
Java			
1970-1980	1.44	-1.37	-0.90
1980-1985	1.96	-3.53	-3.32
1985-1988	-0.76	15.19	-2.10
West Java			
1989-2000	0.28	na	-0.91
East Java			
1989-2000	0.16	-0.16	-1.91
Central Java			
1989-2000	0.27	0.17	-0.60
Off-Java			
1970-1980	2.12	1.00	3.79
1980-1985	2.96	0.53	1.89
1985-1988	2.49	10.05	4.74
South Sulawesi			
1989-2000	1.05	0.65	1.09
North Sumatra			
1989-2000	0.98	na	na
South Sumatra			
1989-2000	0.85	na	na
Lampung			
1989-2000	na	2.33	2.60
Indonesia			
1970-1980	1.71	-0.69	0.12
1980-1985	2.38	-2.16	-1.77
1985-1988	0.65	13.20	0.33
1989-2000	0.43	0.28	-0.29

Note: The historical trends were calculated from data published by the Central Bureau of Statistics. The figures for 1989-2000 are projections based on a CARD/MOA Special Study (Input Demand Projection 1990).

Table 4.2. Supply and demand parameters used in the analytical policy system for South Sulawesi

Area Response Elasticities

Price/Crop	WL Rice	Corn	Cassava	Peanuts	Mungbeans	Soybeans
Rice	0.30	-0.30	-0.07	0.00	0.00	-0.40
Corn	-0.22	0.40	-0.20	-0.15	-0.30	-0.25
Cassava	0.00	-0.25	0.14	-0.25	-0.08	-0.05
Peanuts	0.00	0.00	0.00	0.90	-0.05	-0.25
Mungbeans	0.00	0.00	-0.39	-0.15	0.40	0.00
Soybeans	0.00	-0.02	0.00	-0.15	-0.12	0.77
Lag (area)	0.60	0.48	0.21	0.00	0.50	0.38

Output Productivity and Input Demand Elasticities

Factor/Price	WL rice	Corn	Cassava	Soybeans
Yield per ha wrt				
Output price	0.05	0.38	0.30	0.07
Fertilizer price	-0.02	-0.28	-0.01	-0.10
Wage rate	-0.03	-0.10	-0.10	-0.06
Fertilizer demand wrt				
Output price	0.34	0.64	1.00	0.80
Fertilizer price	-0.26	-0.48	-0.80	-0.82
Wage rate	-0.08	-0.22	-0.10	-0.05
Labor demand wrt				
Output price	0.14	0.43	1.04	0.68
Fertilizer price	0.03	-0.36	0.06	-0.05
Wage rate	-0.16	-0.07	-0.35	-0.35

WL - Wetland DL - Dryland

Price and Income Elasticities of Commodity Demand

Price/Demand	Rice	Corn	Cassava	Peanuts	Mungbeans	Soybeans	Sugar
Rice	-0.45	0.10	0.30	0.00	0.00	0.00	0.02
Corn	0.08	-0.30	0.12	-0.08	-0.60	0.00	0.02
Cassava	0.06	0.10	-0.45	-0.08	0.00	0.00	0.02
Peanuts	0.02	-0.02	-0.05	-0.30	-0.30	0.00	-0.05
Mungbeans	0.02	-0.02	0.05	0.00	0.50	0.00	0.08
Soybeans	0.02	0.02	0.05	0.20	0.00	-0.40	0.02
Sugar	0.03	-0.10	-0.00	0.02	0.01	0.02	-0.30
Food Exp.	0.52	0.45	0.30	0.40	0.70	0.56	0.58

Table 4.3. Assumptions on regional income and other linkages

Variables	1988	1989	1990	1991	1992	1993
Inflation (%)	5.49	8.00	8.00	8.00	8.00	8.00
Inflation Index (1985=1)	1.24	1.34	1.45	1.57	1.69	1.83
Population Growth Rate (%)	1.51	1.51	1.51	1.51	1.51	1.51
Population (mil)	6.70	6.80	6.90	7.01	7.11	7.22
Real GRDP Growth (%)		5.00	5.00	5.00	5.00	5.00
Real GRDP Per Cap ('000 Rp)	280.20	289.83	299.79	310.09	320.75	331.77
Food Expenditure Per Cap ('000 Rp)	182.13	188.39	194.86	201.56	208.49	215.65

Table 4.4. Baseline assumptions on area, yield, and prices

Assumptions	1989	1990	1991	1992	1993
			Percent		
Wetland Rice					
Area	1.00	1.00	0.75	0.75	0.75
Yield	1.60	1.60	1.60	1.60	1.60
Dryland Rice					
Area	0.50	0.50	0.50	0.50	0.50
Yield	1.00	1.00	1.00	1.00	1.00
Real price	2.25	1.89	1.80	1.80	1.71
Corn					
Area	1.37	1.37	1.37	1.37	1.37
Yield	2.75	3.00	3.25	3.50	3.50
Real price	1.08	1.17	1.08	1.08	1.08
Cassava					
Area	0.50	0.50	0.50	0.50	0.50
Yield	1.75	1.75	1.75	1.75	1.75
Real price	0.81	1.17	1.53	1.98	2.34
Peanut					
Area	0.99	0.99	0.99	0.99	0.99
Yield	1.00	1.00	1.00	1.00	1.00
Real price	0.00	0.45	0.45	0.45	0.45
Mungbeans					
Area	0.50	0.50	0.50	0.50	0.50
Yield	0.94	0.94	0.94	0.94	0.94
Real price	1.35	1.26	1.26	1.17	1.17
Soybeans					
Area	3.00	3.00	3.00	3.00	3.00
Yield	1.03	1.03	1.03	1.03	1.03
Real price	0.27	0.36	0.27	0.27	0.36

Table 4.5. Summary of baseline simulation, 1988-93

Items/Year	1988	1989	1990	1991	1992	1993	Avg. growth (% per yr)
Area harvested (1000 ha)							
Wetland Rice	682.94	711.37	725.26	730.48	739.52	747.22	1.82
Dryland Rice	15.35	15.42	15.50	15.58	15.66	15.73	0.50
Corn	335.49	346.75	355.54	363.33	370.33	376.57	2.34
Cassava	39.42	40.95	41.16	41.12	41.07	41.05	0.82
Peanuts	56.63	57.19	57.76	58.33	58.91	59.49	0.99
Mungbeans	58.88	59.18	59.47	59.77	60.07	60.37	0.50
Soybeans	40.47	43.73	46.15	48.11	49.95	51.77	5.06
Total	1229.18	1274.59	1300.84	1316.73	1335.50	1352.21	1.93
Crop yields (mt/ha)							
Wetland rice	5.15	5.24	5.32	5.41	5.50	5.59	1.66
Dryland rice	2.50	2.53	2.55	2.58	2.60	2.63	1.00
Corn	1.69	1.73	1.79	1.84	1.91	1.98	3.20
Cassava	10.58	10.79	11.01	11.26	11.52	11.80	2.21
Peanuts	1.03	1.04	1.05	1.07	1.08	1.09	1.00
Mungbeans	0.89	0.90	0.91	0.92	0.93	0.94	0.94
Soybeans	1.33	1.34	1.36	1.37	1.38	1.39	0.90
Real farm prices (rp/kg)							
Paddy	162.45	166.11	169.25	172.29	175.40	178.40	1.89
Corn	110.44	111.63	112.93	114.15	115.39	116.63	1.10
Cassava	80.14	80.79	81.73	82.98	84.62	86.60	1.57
Peanuts	909.03	909.03	913.12	917.23	921.35	925.50	0.36
Mungbeans	559.75	567.31	574.46	581.70	588.50	595.39	1.24
Soybeans	427.24	428.39	429.94	431.10	432.26	433.82	0.31
Total fertilizer use ('000 ton)							
Wetland rice	221.95	233.91	246.23	259.11	272.67	286.85	5.26
Dryland rice	39.46	41.43	43.50	45.68	47.96	50.36	5.00
Corn	42.78	46.19	49.89	53.87	58.16	62.79	7.97
Cassava	1.37	1.40	1.42	1.46	1.50	1.54	2.37
Peanuts	19.38	20.16	20.96	21.80	22.67	23.58	4.00
Soybeans	39.01	42.48	46.42	50.84	53.95	55.37	7.29
Total	363.96	385.57	408.43	432.76	456.91	480.50	5.71
Trade surplus ('000 mt)							
Rice	1064.71	1059.23	1106.29	1126.16	1158.25	1185.70	2.19
Corn	280.21	301.83	322.62	344.02	366.57	389.14	6.79
Cassava	256.25	273.88	280.90	286.42	292.55	299.75	3.20
Peanuts	18.28	18.54	18.82	19.11	19.41	19.72	1.53
Mungbeans	38.56	39.74	40.14	40.52	40.92	41.30	1.39
Soybeans	41.32	45.32	48.41	51.02	53.52	56.04	6.30
Real farm income (bil. Rp)							
Rice	506.31	553.05	588.58	617.92	651.71	685.02	6.24
Corn	43.76	48.26	52.94	57.83	63.07	68.48	9.37
Cassava	31.21	33.46	34.87	36.30	37.98	39.96	5.07
Peanuts	40.68	41.76	43.08	44.43	45.80	47.20	3.02
Soybeans	22.55	24.78	26.62	28.22	29.79	31.41	6.87

Table 4.5. Continued

Items/Year	1988	1989	1990	1991	1992	1993	Avg. growth (% per yr)
Net returns per ha ('000 Rp)							
Rice	725.08	760.94	794.56	828.25	862.99	897.84	4.37
Corn	130.43	139.18	148.89	159.16	170.30	181.85	6.87
Cassava	791.78	817.14	847.28	882.62	924.79	973.36	4.22
Peanuts	718.37	730.19	745.86	761.61	777.46	793.40	2.01
Soybeans	557.02	566.65	576.93	586.62	596.34	606.75	1.72
Per capita consumption (kg)							
Rice	152.99	166.24	168.12	170.10	172.16	174.34	2.69
Corn	18.52	18.80	19.07	19.36	19.65	19.97	1.51
Cassava	12.79	12.99	13.15	13.29	13.40	13.49	1.07
Peanuts	1.96	1.98	2.00	2.02	2.05	2.07	1.11
Mungbeans	1.21	1.24	1.27	1.30	1.33	1.35	2.24
Soybeans	0.71	0.72	0.73	0.75	0.76	0.77	1.79

Table 4.6. Food crop diversification simulation assumptions on area, yield, and prices

Assumptions	1989	1990	1991	1992	1993
			Percent		
Wetland Rice					
Area	1.00	1.00	0.75	0.75	0.75
Yield	1.60	1.60	1.60	1.60	1.60
Dryland Rice					
Area	0.50	0.50	0.50	0.50	0.50
Yield	1.00	1.00	1.00	1.00	1.00
Real price	0.00	0.00	0.00	0.00	0.00
Corn					
Area	1.37	1.37	1.37	1.37	1.37
Yield	2.75	3.00	3.25	3.50	3.50
Real price	1.80	1.80	1.80	1.80	1.80
Cassava					
Area	0.50	0.50	0.50	0.50	0.50
Yield	1.75	1.75	1.75	1.75	1.75
Real price	0.81	1.17	1.53	1.98	2.34
Peanut					
Area	0.99	0.99	0.99	0.99	0.99
Yield	1.00	1.00	1.00	1.00	1.00
Real price	0.09	0.09	0.18	0.18	0.00
Mungbeans					
Area	0.50	0.50	0.50	0.50	0.50
Yield	0.94	0.94	0.94	0.94	0.94
Real price	1.35	1.26	1.26	1.17	1.17
Soybeans					
Area	3.00	3.00	3.00	3.00	3.00
Yield	1.03	1.03	1.03	1.03	1.03
Real price	1.80	1.80	1.80	1.80	1.80

Table 4.7. Summary of food crop diversification simulation, 1988-93

Items/Year	1988	1989	1990	1991	1992	1993	Avg. growth (% per yr)
Area harvested (1000 ha)							
Wetland rice	682.94	709.61	716.46	712.43	710.78	707.02	0.71
Dryland rice	15.35	15.42	15.50	15.58	15.66	15.73	0.50
Corn	335.49	347.60	361.14	375.35	389.86	404.33	3.80
Cassava	39.42	40.95	41.16	41.13	41.07	41.04	0.82
Peanuts	56.63	57.19	57.76	58.33	58.91	59.49	0.99
Mungbeans	58.88	59.18	59.47	59.77	60.07	60.37	0.50
Soybeans	40.47	43.73	46.34	48.36	50.21	52.01	5.16
Total	1229.18	1273.69	1297.83	1310.95	1326.55	1340.00	1.75
Crop yields (mt/ha)							
Wetland rice	5.15	5.23	5.31	5.40	5.48	5.57	1.57
Dryland rice	2.50	2.53	2.55	2.58	2.60	2.63	1.00
Corn	1.69	1.74	1.80	1.86	1.93	2.00	3.48
Cassava	10.58	10.79	11.01	11.26	11.52	11.80	2.21
Peanuts	1.03	1.04	1.05	1.07	1.08	1.09	1.00
Mungbeans	0.89	0.90	0.91	0.92	0.93	0.94	0.94
Soybeans	1.33	1.34	1.36	1.37	1.39	1.40	1.01
Real farm prices (rp/kg)							
Paddy	162.45	162.45	162.45	162.45	162.45	162.45	0.00
Corn	110.44	112.42	114.45	116.51	118.60	120.74	1.80
Cassava	80.14	80.79	81.73	82.98	84.62	86.60	1.57
Peanuts	909.03	909.84	910.66	912.30	913.94	913.94	0.11
Mungbeans	559.75	567.31	574.46	581.70	588.50	595.39	1.24
Soybeans	427.24	434.93	442.76	450.73	458.84	467.10	1.80
Total fertilizer use ('000 ton)							
Wetland rice	221.95	232.16	242.83	254.00	265.68	277.90	4.60
Dryland rice	39.46	41.43	43.50	45.68	47.96	50.36	5.00
Corn	42.78	46.40	50.32	54.57	59.18	64.18	8.45
Cassava	1.37	1.40	1.42	1.46	1.50	1.54	2.37
Peanuts	19.38	20.16	20.96	21.80	22.67	23.58	4.00
Soybeans	39.01	43.00	47.53	52.69	56.59	58.75	8.56
Total	363.96	384.54	406.57	430.19	453.58	476.31	5.53
Trade surplus ('000 mt)							
Rice	1064.71	1037.84	1048.34	1023.58	1004.60	977.02	-1.69
Corn	280.21	304.62	333.26	365.56	401.39	439.31	9.41
Cassava	256.25	274.33	281.78	287.69	294.13	301.60	3.33
Peanuts	18.28	18.51	18.74	18.98	19.23	19.48	1.28
Mungbeans	38.56	39.78	40.20	40.62	41.05	41.47	1.47
Soybeans	41.32	45.40	48.80	51.58	54.19	56.81	6.59
Real farm income (bil. rp)							
Rice	506.31	537.31	554.09	562.67	573.12	581.90	2.84
Corn	43.76	49.04	55.12	62.00	69.72	78.10	12.28
Cassava	31.21	33.46	34.88	36.31	37.98	39.95	5.07
Peanuts	40.68	41.81	42.95	44.15	45.38	46.53	2.72
Soybeans	22.55	25.24	27.70	29.92	32.15	34.45	8.86
Total	644.51	686.86	714.73	735.05	758.36	780.93	3.92

Table 4.7. Continued

Items/Year	1988	1989	1990	1991	1992	1993	Avg. growth (% per yr)
Net returns per ha ('000 rp)							
Rice	725.08	741.09	756.99	772.89	788.95	805.12	2.12
Corn	130.43	141.09	152.64	165.19	178.85	193.16	8.17
Cassava	791.78	817.14	847.28	882.62	924.79	973.36	4.22
Peanuts	718.37	730.96	743.54	756.92	770.32	782.17	1.72
Soybeans	557.02	577.16	597.73	618.77	640.29	662.31	3.52
Per capita consumption (kg)							
Rice	152.99	168.06	171.53	175.12	178.82	182.64	3.65
Corn	18.52	18.72	18.92	19.13	19.35	19.59	1.12
Cassava	12.79	12.92	13.03	13.12	13.19	13.23	0.68
Peanuts	1.96	1.98	2.01	2.04	2.07	2.10	1.44
Mungbeans	1.21	1.24	1.26	1.28	1.31	1.33	1.90
Soybeans	0.71	0.72	0.72	0.73	0.74	0.75	1.19
Calories per capita (kg/day)							
Rice	1508.90	1657.57	1691.82	1727.18	1763.71	1801.34	3.65
Corn	162.40	164.15	165.91	167.75	169.69	171.71	1.12
Cassava	38.55	38.95	39.28	39.55	39.74	39.88	0.68
Peanut	24.21	24.57	24.94	25.29	25.64	26.00	1.44
Mungbeans	11.46	11.68	11.91	12.13	12.35	12.59	1.90
Soybeans	6.42	6.49	6.57	6.65	6.73	6.81	1.19
Total (above crops only)	1751.94	1903.42	1940.43	1978.55	2017.87	2058.33	3.31
Protein per capita(gm/day)							
Rice	28.50	31.31	31.96	32.62	33.31	34.03	3.65
Corn	4.21	4.26	4.30	4.35	4.40	4.45	1.12
Cassava	0.32	0.32	0.32	0.32	0.33	0.33	0.68
Peanuts	1.36	1.38	1.40	1.42	1.44	1.46	1.44
Mungbeans	0.74	0.75	0.77	0.78	0.79	0.81	1.90
Soybean	0.68	0.68	0.69	0.70	0.71	0.72	1.19
Total (above crops only)	35.80	38.70	39.44	40.20	40.98	41.79	3.17

Table 4.8. Constant real price simulation assumptions on area, yield, and prices

Assumptions	1989	1990	1991	1992	1993
			Percent		
Wetland Rice					
Area	1.00	1.00	0.75	0.75	0.75
Yield	1.60	1.60	1.60	1.60	1.60
Dryland Rice					
Area	0.50	0.50	0.50	0.50	0.50
Yield	1.00	1.00	1.00	1.00	1.00
Real price	0.00	0.00	0.00	0.00	0.00
Corn					
Area	1.37	1.37	1.37	1.37	1.37
Yield	2.75	3.00	3.25	3.50	3.50
Real price	0.00	0.00	0.00	0.00	0.00
Cassava					
Area	0.50	0.50	0.50	0.50	0.50
Yield	1.75	1.75	1.75	1.75	1.75
Real price	0.00	0.00	0.00	0.00	0.00
Peanut					
Area	0.99	0.99	0.99	0.99	0.99
Yield	1.00	1.00	1.00	1.00	1.00
Real price	0.00	0.00	0.00	0.00	0.00
Mungbeans					
Area	0.50	0.50	0.50	0.50	0.50
Yield	0.94	0.94	0.94	0.94	0.94
Real price	0.00	0.00	0.00	0.00	0.00
Soybeans					
Area	3.00	3.00	3.00	3.00	3.00
Yield	1.03	1.03	1.03	1.03	1.03
Real price	0.00	0.00	0.00	0.00	0.00

Table 4.9. Summary of constant real price simulation, 1988-93

Items/Year	1988	1989	1990	1991	1992	1993	Avg. growth (% per yr)
Area harvested (1000 ha)							
Wetland Rice	682.94	711.37	722.14	723.24	727.54	730.13	1.36
Dryland Rice	15.35	15.42	15.50	15.58	15.66	15.73	0.50
Corn	335.49	346.75	357.11	367.16	377.18	387.32	2.91
Cassava	39.42	40.95	41.48	41.80	42.08	42.35	1.45
Peanuts	56.63	57.19	57.76	58.33	58.91	59.49	0.99
Mungbeans	58.88	59.18	59.47	59.77	60.07	60.37	0.50
Soybeans	40.47	43.73	46.74	49.37	51.92	54.51	6.14
Total	1229.18	1274.59	1300.20	1315.25	1333.35	1349.90	1.90
Crops yields (mt/ha)							
Wetland Rice	5.15	5.23	5.31	5.40	5.48	5.57	1.57
Dryland Rice	2.50	2.53	2.55	2.58	2.60	2.63	1.00
Corn	1.69	1.73	1.77	1.82	1.88	1.94	2.77
Cassava	10.58	10.76	10.95	11.14	11.33	11.53	1.73
Peanuts	1.03	1.04	1.05	1.07	1.08	1.09	1.00
Mungbeans	0.89	0.90	0.91	0.92	0.93	0.94	0.94
Soybeans	1.33	1.34	1.35	1.37	1.38	1.39	0.88
Real farm prices (rp/kg)							
Paddy	162.45	162.45	162.45	162.45	162.45	162.45	0.00
Corn	110.44	110.44	110.44	110.44	110.44	110.44	0.00
Cassava	80.14	80.14	80.14	80.14	80.14	80.14	0.00
Peanuts	909.03	909.03	909.03	909.03	909.03	909.03	0.00
Mungbeans	559.75	559.75	559.75	559.75	559.75	559.75	0.00
Soybeans	427.24	427.24	427.24	427.24	427.24	427.24	0.00
Total fertilizer use ('000 ton)							
Wetland rice	221.95	232.16	242.83	254.00	265.68	277.90	4.60
Dryland rice	39.46	41.43	43.50	45.68	47.96	50.36	5.00
Corn	42.78	45.87	49.19	52.74	56.56	60.64	7.23
Cassava	1.37	1.38	1.40	1.41	1.42	1.43	0.79
Peanuts	19.38	20.16	20.96	21.80	22.67	23.58	4.00
Soybeans	39.01	42.39	46.19	50.48	53.45	54.70	7.03
Total	363.96	383.39	404.07	426.11	447.74	468.61	5.18
Trade surplus ('000 mt)							
Rice	1064.71	1046.46	1073.13	1069.39	1075.16	1074.88	0.20
Corn	280.21	299.95	320.45	342.58	366.93	392.63	6.98
Cassava	256.25	273.46	282.29	289.38	296.23	303.14	3.43
Peanuts	18.28	18.52	18.78	19.03	19.28	19.53	1.34
Mungbeans	38.56	39.74	40.12	40.49	40.87	41.23	1.35
Soybeans	41.32	45.31	49.06	52.44	55.77	59.20	7.46
Real farm income (bil. rp)							
Rice	506.31	538.63	558.43	571.12	586.49	600.72	3.49
Corn	43.76	47.27	50.97	54.97	59.34	63.94	7.88
Cassava	31.21	33.09	34.20	35.16	36.11	37.07	3.50
Peanuts	40.68	41.76	42.86	43.97	45.10	46.25	2.60
Soybeans	22.55	24.70	26.76	28.65	30.53	32.48	7.58

Table 4.9. Continued

Items/Year	1988	1989	1990	1991	1992	1993	Avg. growth (% per yr)
Net returns per ha ('000 rp)							
Rice	725.08	741.11	757.05	773.02	789.16	805.41	2.12
Corn	130.43	136.32	142.73	149.72	157.33	165.08	4.82
Cassava	791.78	808.04	824.52	841.21	858.12	875.27	2.03
Peanuts	718.37	730.19	742.00	753.79	765.59	777.38	1.59
Soybeans	557.02	564.80	572.56	580.32	588.06	595.80	1.36
Per capita consumption (kg)							
Rice	152.99	167.63	170.60	173.63	176.70	179.83	3.33
Corn	18.52	18.81	19.10	19.39	19.69	19.99	1.53
Cassava	12.79	12.92	13.06	13.19	13.32	13.46	1.02
Peanuts	1.96	1.98	2.01	2.04	2.06	2.09	1.36
Mungbeans	1.21	1.24	1.27	1.30	1.33	1.36	2.39
Soybeans	0.71	0.72	0.73	0.75	0.76	0.78	1.91
Calories per capita/day							
Rice	1508.90	1653.34	1682.64	1712.47	1742.82	1773.71	3.33
Corn	162.40	164.89	167.41	169.98	172.58	175.23	1.53
Cassava	38.55	38.95	39.34	39.75	40.15	40.56	1.02
Peanut	24.21	24.54	24.87	25.21	25.56	25.90	1.36
Mungbeans	11.46	11.73	12.01	12.30	12.60	12.90	2.39
Soybeans	6.42	6.54	6.66	6.79	6.92	7.05	1.91
Total (above crops only)	1751.94	1899.99	1932.95	1966.50	2000.62	2035.34	3.08
Protein per capita(gm/day)							
Rice	28.50	31.23	31.78	32.35	32.92	33.50	3.33
Corn	4.21	4.28	4.34	4.41	4.48	4.54	1.53
Cassava	0.32	0.32	0.32	0.33	0.33	0.33	1.02
Peanuts	1.36	1.37	1.39	1.41	1.43	1.45	1.36
Mungbeans	0.74	0.75	0.77	0.79	0.81	0.83	2.39
Soybeans	0.68	0.69	0.70	0.72	0.73	0.74	1.91
Total (food crops only)	35.80	38.64	39.32	40.00	40.70	41.40	2.98

APPENDIX A. TECHNICAL PAPERS AND RESEARCH BRIEFS PRODUCED FROM CARD/MOA STUDY

June 1990

Technical Papers

1. Assessments of Food Demand Trends: Methods and Preliminary Analysis.
Basile Goungetas and Helen H. Jensen. June 1989.

2. A National Food Crops Policy Model for Indonesia.
Paul J. Heytens. July 1989.

3. SUSENAS Data Organization and Processing: CARD/MOA's Use of the Indonesian National Social Economic Surveys.
Gary L. Stampley. July 1989.

4. The SAS Macro Language.
Basile Goungetas. November 1989.

5. Supply Response Analysis for Wetland Rice Production in South Sulawesi.
T. Kesavan, Pantjar Simatupang, and Nizwar Syaf'at. November 1989.

6. Supply Response Analysis for Corn Production in South Sulawesi.
T. Kesavan, Pantjar Simatupang, and Nizwar Syafa'at. November 1989.

7. Fertilizer Response Special Study Final Report.
Paul J. Heytens, Klaus Altemeier, Nuryanto Daris, Wennu Astuti, and Suprapti. December 1989.

8. The Food Marketing System, Price Analysis and Guidelines to Develop Consistent Data for a Regional Information System.
T. Kesavan. January 1990.

9. A Regional Policy Analytical System for Food Crops in South Sulawesi.
T. Kesavan. March 1990.

10. The Assessment of Food Demand Trends in Indonesia: Methods and Projections.
Basile Goungetas, Helen H. Jensen, and Stanley R. Johnson. March 1990.

11. A Livestock Feed Use Projection Model for Indonesia.
Paul J. Heytens, Tahlim Sudaryanto, Muchjidin Rachmat, and Waluyo. March 1990.

Research Briefs

1. National Food Crops Policy Model: Repelita V Baseline.
July 1989.

2. National Food Crops Policy Model: Policy Applications.
July 1989.

3. Fertilizer Response Special Study: Preliminary Results.
August 1989.

4. A Note on Poultry Policy in Indonesia.
September 1989.

5. Fertilizer Response Special Study: Further Preliminary Results.
October 1989.

6. National Food Crops Policy Model: World Market Simulation Update.
November 1989.

7. Fertilizer Response Special Study: Preliminary Physical Response Analysis.
November 1989.

8. Supply Response Analysis: Preliminary Results for Rice and Corn in South Sulawesi.
November 1989.

9. A Note on Rice's Conribution to Rural Income and Employment Growth.
November 1989.

10. Preliminary Demand System Estimates from Sumatra.
November 1989.

11. A Note on Indonesia's Wetland Rice Production Systems.
December 1989.

12. Comparative Advantage in Indonesia's Wetland Rice Areas.
December 1989.

13. National Food Crops Policy Model: Food Crops Diversification Simulation.
December 1989.

14. A Note on Sugarcane Production in Java.
December 1989.

15. Preliminary Harvested Area Projections.
January 1990.

16. Livestock Feed Use Projection Model: Repelita V Baseline.
March 1990.

17. Food Demand Trends in Indonesia: Projections of Rice Consumption.
March 1990.

18. Input Demand Projection Special Study: Fertilizer to 2000.
March 1990.

19. Input Demand Projection Special Study: Labor Use to 2000.
March 1990.

20. Food Demand Trends in Indonesia: Projections of Red Meat and Poultry Consumption.
May 1990.

21. Food Demand Trends in Indonesia: Alternative Regional Income Growth Scenarios.
May 1990.

22. Food Demand Trends in Indonesia: An Assessment of Future Rice Consumption Behavior.
May 1990.

23. South Sulawesi Food Crops Analytical System: Baseline Simulation.
May 1990.

24. South Sulawesi Food Crops Analytical System: Policy Applications.
May 1990.

25. Price Integration of Java and Off Java Markets--Preliminary Results for Corn and Cassava.
May 1990.

APPENDIX B. NFDP MODEL PROJECTIONS

The NFDP model projections are made in terms of changes in the budget share of each food commodity from a base year as follows (we have dropped the subscript r for clarity). From equation (2.4) we can write the budget share for the base year,

$$w_i^o = \alpha_{io} + \sum_s \alpha_{is} D_s^o + \sum_j \tau_{ij} \ln(p_j^o) + \beta_i [\ln(y^o) - \ln(P^o)], \qquad (B.1)$$

and the budget share for some future year,

$$w_i^* = \alpha_{io} + \sum_s \alpha_{is} D_s^* + \sum_j \tau_{ij} \ln(p_j^*) + \beta_i [(\ln(y^*) - \ln(P^*)]. \qquad (B.2)$$

Subtracting (2A.1) from (2A.2) yields

$$(w_i^* - w_i^o) = \sum_s \alpha_{is}(D_s^* - D_s^o) + \sum_j \tau_{ij} [\ln(p_j^*/p_j^o]$$

$$+ \beta_i \{[\ln(y^*/y^o) - [\ln(P^*) - \ln(P^o)]\} \qquad (B.3)$$

which is the projected change in the budget share of the i^{th} food commodity between the base and future year. The future year values of the demographic variables, prices, and total expenditure used in equation (B.3) can be expressed in terms of the corresponding base year values as follows:

$$D_s^* = (1 + \pi_s) D_s^o \quad \text{or} \quad (D_s^* - D_s^o) = \pi_s D_s^o, \qquad (B.4)$$

$$p_j^* = (1 + \delta_j) p_j^o = \delta_j^* p_j^o \quad \text{or} \quad (p_j^*/p_j^o) = 1 + \delta_j = \delta_j^*, \qquad (B.5)$$

$$y^* = (1 + \sigma) y^o = \sigma^* y^o \quad \text{or} \quad (y^*/y^o) = 1 + \sigma = \sigma^*. \qquad (B.6)$$

Using Stones' price index with the base year budget shares yields

$$\ln P^{o} = \sum_j w_j^{o} \ln(p_j^{o}), \text{ and}$$

$$\ln P^{*} = \sum_j w_j^{o} \ln(p_j^{*}) = \sum_j w_j^{o} \ln[(1 + \delta_j)p_j^{o}],$$

from which we obtain

$$[\ln(P^{*}) - \ln(P^{o})] = \sum_j w_j^{o} \ln(1 + \delta_j). \tag{B.7}$$

Substituting (B.4) through (B.7) into (B.3) and solving for w_i^{*} yields the equation that is used to compute the projected budget shares for the representative household in the future period,

$$w_i^{*} = w_i^{o} + \sum_s \alpha_s (\pi_s D_s^{o}) + \sum_j \tau_{ij} \ln(1 + \delta_j)$$

$$+ \beta_i \{[\ln(1 + \delta)] - [\sum_j w_j^{o} \ln(1 - \delta_j)]\}. \tag{B.8}$$

Using these projected budget shares, it is possible to estimate future expenditure and quantity consumed. For the representative household, expenditure (e_i) is obtained as the product of the budget share and total expenditure, and quantity consumed (x_i) is obtained by dividing expenditure by the price. Hence, the growth rates of household expenditure and consumption, respectively, are given by

$$(e_i^{*}/e_i^{o}) - 1, \tag{B.9}$$

$$(x_i^{*}/x_i^{o}) - 1 = [e_i^{*}/p_i^{*})/(e_i^{*}/p_i^{o})] - 1 = \{[e_I^{*}/(1 + \delta_i)p_i^{o}]/(e_i^{o}/p_i^{o})\} - 1$$

$$= [e_i^{*}/e_i^{o}(1 + \delta_i)] - 1. \tag{B.10}$$

Regional expenditure (E_i) and total consumption (X_i) are computed by dividing the corresponding quantity for the representative household by the household size to obtain estimated per capita quantity and multiplying the result by the number of people in the region. Hence, the growth rates of regional expenditure and total consumption, respectively, are given by

$$(E_i^*/E_i^o) - 1 = [(e_i^*Z^*/H^*)/(e_i^oZ^o/H^o)] - 1 = (e_i^*Z^*H^o/e_i^oZ^oH^*) - 1, \qquad \text{(B.11)}$$

$$(X_i^*/X_i^o) - 1 = [(x_i^*Z^*/H^*)/(x_i^oZ^o/H^o)] - 1 = (x_i^*Z^*H^o/x_iZ^oH^*) - 1$$

$$= \{[(e_i^*/p_i^*)Z^*H^o]/[(e_i^o/p_i^o)Z^oH^*]\} - 1$$

$$= \{[e_i^*Z^*H^o]/[e_i^*(1+\delta_i)Z^oH^*]\} - 1, \qquad \text{(B.12)}$$

where Z is the population size of the region and H is the size of the representative household. It can easily be seen that the growth rates of the regional quantities are functions of the corresponding quantities for the representative household, the growth rate in population, and (inversely) the growth rate of the size of the representative household.

Expressions (B.8) through (B.12), along with the base year values and parameter estimates from the 1987 SUSENAS, were used to build the NFDP spreadsheet files.

The projections generated by the CARD baseline scenario are based on a constant real prices assumption. The implications of such a scenario can be traced as follows. Constant real price implies that

$$(p_i^*/P^*) = (p_i^o/P^o) \quad \text{or} \quad (P^*/P^o) = (p_i^*/p_i^o) \quad \text{for all i; i.e.,}$$

$$\delta_1^* = \delta_2^* = \ldots = \delta_n^* \quad \text{or} \quad \delta_1 = \delta_2 = \ldots = \delta_n = \delta.$$

In such a case, because budget shares add up to one,

$$\sum_j w_j^o \ln(1 - \delta_j) = [\ln(1 + \delta)](\sum_j w_j^o) = \ln(1 + \delta),$$

and using the homogeneity restriction

$$\sum_j \tau_{ij} \ln(1 + \delta_j) = [\ln(1 + \delta)](\sum_j \tau_{ij}) = 0.$$

Therefore, under a constant real prices assumption, equation (B.8) reduces to

$$w_i^* = w_i^o + \sum_s \alpha_s(\pi_s D_s^o) + \beta_i[\ln(1 + \sigma) - \ln(1 + \delta)]$$

$$= w_i^o + \sum_s \alpha_s(\pi_s D_s^o) + \beta_i \ln[(1 + \sigma)/(1 + \delta)]. \qquad \text{(B.13)}$$

This expression makes it clear that, under such an assumption, price effects are absent, and the projected budget shares depend on the growth in the demographic variables (α_s's) and real total expenditure (σ), and the inflation rate (δ).

APPENDIX C. NATIONAL FOOD DEMAND PROJECTIONS MODEL SPREADSHEET FILES AND PROGRAMS

Spreadsheet Files

The CARD/MOA National Food Demand Projections Model consists of the following LOTUS 1-2-3 files:

File Name	File Description
1. base.wk1	Base-year values for all independent variables by survey
2. budget.wk1	Budget shares by budgeting stage and survey
3. model.doc	This document (in WordPerfect 5.0 format)
4. pop.wk1	Population projections by age/sex group
5. popgr.wk1	Population growth rates by age/sex group
6. rjava.wk1	Forecasting model for rural Java
7. rojava.wk1	Forecasting model for rural off-Java
8. st1par.wk1	Stage 1 parameter estimates by survey
9. st2par.wk1	Stage 2 parameter estimates by survey
10. st3apar.wk1	Stage 3 (palawija & wheat) parameter estimates by survey
11. st3bpar.wk1	Stage 3 (meat & fish) parameter estimates by survey
12. ujava.wk1	Forecasting model for urban Java
13. uojava.wk1	Forecasting model for urban off-Java

Files 6, 7, 12, and 13 are the main programs for the four regions: rural Java, rural off-Java, urban Java, and urban off-Java. The remaining files are auxiliary files that will be needed only in special circumstances.

Each of the main programs contains the food demand projections model for the corresponding region based on the estimated parameters and base year values from the 1987 SUSENAS survey. The auxiliary files will be needed only if one wants to run the food demand projections model using parameters and base year values from the 1984 or 1981 SUSENAS surveys.

Main Programs

Each of the main programs contains the following components:

Component	Location in Spreadsheet
Growth Rates	
Age/sex groups	C13 - J17
Total population	C18 - J18
Commodity prices	C20 - J43
Real total (food + nonfood) expenditure	C45 - J45
Parameter Estimates	
Food/nonfood sector	Q8 - T18
Food sector	Q27 - Z43
Palawija & wheat sector	Q52 - S61
Meat & fish sector	Q70 - T80
Base Year Values	
Independent variables	B13 - B45
Food/Nonfood sector budget shares	Q19 - T19
Food sector budget shares	Q44 - Z44
Palawija & wheat sector budget shares	Q62 - S62
Meat & fish sector budget shares	Q81 - T81
Projections	
Budget shares (representative household)	A100 - K148
Total expenditure (representative household)	A150 - K192
Total consumption growth rate (rep. household)	A194 - K242
Total expenditure growth rate (region)	A244 - K289
Total consumption growth rate (region)	A291 - K336

Running the Main Programs

The typical sequence of steps to run the food demand projections model for any of the four regions is as follows:

1. Load the appropriate main file.
2. Change as desired the growth rates for real total expenditure and all commodity prices except for total food, the palawija group, and the meat & fish group. These rates are computed automatically from the rates of the commodities making up each of these groups.

3. Go to the appropriate location in the spreadsheet to review the projections.

National Projections

National projections can be obtained as a weighted average of the four regional projections. The results presented in Tables 6 through 9 were computed in such a fashion using the 1985-95 average shares of the Java and off-Java regions in the total population of Indonesia. These weights were normalized and set to 1 for urban and rural off-Java, and 1.4876 for urban and rural Java.

Using the Auxiliary Files

If one wishes to run the food demand projections model using parameters from earlier SUSENAS surveys, the appropriate information (parameters and base year values) from files 1, 2, and 8 through 11 must be copied into the corresponding ranges of each of the main programs. The recalculation of the projected budget shares, expenditures, and growth rates for total expenditure and consumption will be automatic.

APPENDIX D. NATIONAL FOOD CROP POLICY MODEL VARIABLE DEFINITIONS

A	Food crop harvested area (1000 HA)*
EXC	Foreign exchange rate (Rp/US$)
GDP	Gross National Product (Rp. billions)*
GDP_1	Gross Food Crop Sector Product (Rp. billions)*
GDP_2	Gross Mining and Defense Sector Product (Rp. billions)
GDP_3	Gross Industrial, Services, and Estate sector product (Rp. billions)*
p	Real food crop commodity wholesale prices (Rp/kg)
P_f	Food commodity price index
P_z	Other goods (GDP3) commodity price index
POP	Population growth rate
q	Real food crop production input prices (Rp/unit)
R	Variable input demands (various units)*
S	Food and nonfood budget shares*
TEXP	Total real consumption expenditures (Rp. billions)*
TEXPC	TEXP per capita (Rp)*
W	Individual food crop commodity expenditure shares*
X_s	Food crop supply (1000 MT)*
X_d	Food crop demand (1000 MT)*
Y	Yield per hectare (MT/HA)*

* Endogenously determined by the model.

APPENDIX E. DATA REQUIREMENTS FOR UPDATING THE NATIONAL FOOD CROP POLICY MODEL BASE YEAR

The national model is structured in a food balance sheet format. Therefore, national data on harvested area, yields, stocks, net trade, intermediate uses (feed, seed, and waste), and human consumption are necessary to update the model base year. In addition, base year wholesale commodity prices are needed. The current version of the model uses prices from the Jakarta wholesale market collected by the Bina Usaha Tani (BINUS) unit of the Food Crops Directorate of the Ministry of Agriculture. A matrix of data needs and sources is found in Appendix Table E.1. In updating the model base year, in some cases the raw data must be converted to the form of the commodity used in the model. The form of the commodity used in the model is summarized in Appendix Table E.2. An example of the model food balance sheets as they appear in the model spreadsheet under the baseline scenario is found in Appendix Table E.3. (In Appendix Table E.3, the years 1986 to 1988 are historical data, and 1989 to 1993 are projections.)

Appendix Table E.1. Data requirements and sources for updating national model base year

Data Type	Unit	Data Source Primary	Secondary
Area harvested	1000 HA	CBS	BINUS/MOA
Yield	MT/HA	CBS	BINUS/MOA
End-year stocks			
Rice and wheat	1000 MT	BULOG	CBS
Other Commodities	1000 MT	CBS	--
Net trade	1000 MT	CBS	BULOG
Seed and waste	1000 MT	CBS	--
Feed use	1000 MT	Estimated from model	D.G. Live-stock
Human consumption	1000 MT	Estimated as a residual	--
Jakarta wholesale prices	RP/KG	BINUS/MOA	CBS

Appendix Table E.2. Form of food crop commodities used in the model

	Commodity Form	
Crop	English	Bahasa Indonesia
Rice	Unmilled rice	Gabah kering
Wheat	Flour	Tepung terigu
Corn	Dry kernals	Pipilan kering
Cassava	Fresh root	Ubi basah
Mungbeans	Dry beans	Bijih kering
Soybeans	Dry beans	Bijih kering
Peanuts	Shelled peanuts	Lepas kulit
Sugar	Granulated sugar	Gula pasir

Appendix Table E.3. Baseline scenario

Commodity Supply and Use	1986	1987	1988	1989	1990	1991	1992	1993
Rice (gabah kering)								
Wetland area harvested (1000 HA)	8888	8796	8882	9177	9270	9351	9432	9513
Wetland yield (MT/HA)	2.89	2.94	3.02	3.06	3.11	3.16	3.21	3.26
Dryland area harvested (1000 HA)	1100	1126	1207	1267	1288	1305	1322	1339
Dryland yield (MT/HA)	1.23	1.28	1.33	1.35	1.37	1.39	1.41	1.42
Total area harvested (1000 HA)	9988	9923	10090	10443	10558	10656	10754	10852
Yield (MT/HA)	2.70	2.75	2.81	2.85	2.90	2.94	2.99	3.03
Rice production (1000 MT)	27013	27263	28399	29769	30570	31334	32113	32901
Beginning stocks (1000 MT)	2725	2128	1561	1225	1697	1889	2016	2069
Domestic supply (1000 MT)	29738	29391	29960	30994	32266	33223	34129	34970
Net imports (1000 MT)	-231	1	35	275	0	0	0	0
Total supply (1000 MT)	29507	29392	29995	31269	32266	33223	34129	34970
Food consumption (1000 MT)	24813	25289	26135	26816	27551	28314	29101	29919
Feed consumption (1000 MT)	97	101	102	107	111	116	121	126
Seed and waste (1000 MT)	2425	2441	2533	2650	2715	2776	2838	2901
Ending stocks (1000 MT)	2172	1561	1225	1697	1889	2016	2069	2024
Wholesale rice price (Rp/kg)	336	378	475	526	580	639	704	774
Farmgate paddy price (Rp/kg)	168	188	238	263	291	320	252	388
Real wholesale rice price (1986 base)	336	349	404	414	423	432	440	448
Wheat (flour)								
Beginning stocks (1000 MT)	230	396	535	591	429	448	468	489
Net imports (1000 MT)	1620	1625	1716	1555	1812	1891	1975	2061
Total supply (1000 MT)	1850	2021	2250	2146	2241	2340	2443	2550
Food consumption (1000 MT)	1454	1486	1659	1717	1793	1872	1954	2040
Ending stocks (1000 MT)	396	535	591	429	448	468	489	510
Wheat flour price (Rp/kg)	392	453	510	556	595	636	680	727
Real flour price (1986 base)	392	418	434	438	434	430	425	421
Corn (pipilan)								
Area harvested (1000 HA)	3143	2626	3203	3277	3357	3440	3524	3608
Average yield (MT/HA)	1.88	1.96	2.06	2.08	2.13	2.17	2.22	2.26

Appendix Table E.3. Continued

Commodity Supply and Use	1986	1987	1988	1989	1990	1991	1992	1993
Corn production (1000 MT)	5921	5155	6588	6826	7144	7475	7818	8172
Net imports (1000 MT)	54	216	33	66	41	16	-5	-24
Total supply (1000 MT)	5975	5371	6621	6893	7185	7491	7813	8148
Food consumption (1000 MT)	4341	4079	4506	4670	4836	5008	5187	5372
Feed consumption (1000 MT)	888	963	1015	1083	1156	1235	1320	1411
Seed and waste (1000 MT)	755	331	1100	1140	1193	1248	1306	1365
Ending-Beg. stocks (1000 MT)	-9	-2	0	0	0	0	0	0
Wholesale corn price (Rp/kg)	166	218	219	240	263	288	315	345
Farmgate corn price (Rp/kg)	141	186	187	205	224	246	269	295
Real Wholesale corn price (1986 base)	166	201	186	189	192	195	197	200
Cassava (ubi basah)								
Area harvested (1000 HA)	1170	1222	1268	1292	1304	1307	1302	1291
Average yield (MT/HA)	11.40	11.70	12.00	12.16	12.42	12.70	12.99	13.31
Cassava production (1000 MT)	13312	14356	15211	15710	16197	16592	16917	17186
Food consumption (1000 MT)	8573	9854	9390	9715	10025	10324	10613	10887
Feed consumption (1000 MT)	242	287	304	314	324	332	338	344
Industrial use and waste (1000 MT)	3279	1866	3042	3142	3239	3318	3383	3437
Net exports (1000 MT)	1218	2349	2475	2539	2609	2618	2582	2518
Ending-Beg. stocks (1000 MT)	0	0	0	0	0	0	0	0
Wholesale cassava price (Rp/kg)	70	98	126	137	150	165	182	202
Farmgate cassava price (Rp/kg)	41	57	74	81	88	97	107	119
Real wholesale cassava price (Rp/kg)	70	90	107	108	110	111	114	117
Mungbeans (bigin kering)								
Area harvested (1000 HA)	293	277	316	342	360	374	383	383
Average yield (MT/HA)	0.73	0.74	0.77	0.77	0.78	0.78	0.78	0.79
Mungbean production (1000 MT)	213	204	243	264	280	291	300	305
Food consumption (1000 MT)	191	183	218	229	241	253	266	280
Feed consumption (1000 MT)	4	4	5	5	6	6	6	6
Seed and waste (1000 MT)	18	17	20	22	23	24	25	25
Net exports (1000 MT)	0	-0	0	7	10	8	3	-6

Appendix Table E.3 Continued

Commodity Supply and Use	1986	1987	1988	1989	1990	1991	1992	1993
Wholesale mungbean price (Rp/kg)	816	859	1140	1232	1332	1442	1560	1685
Farmgate mungbean price (Rp/kg)	618	651	864	934	1010	1093	1183	1277
Real wholesale price (Rp/kg)	816	792	970	971	972	974	976	976
Soybeans (bijih kering)								
Area harvested (1000 HA)	1254	1101	1143	1174	1210	1247	1285	1324
Average yield (MT/HA)	0.98	1.06	1.10	1.11	1.11	1.12	1.13	1.14
Soybean production (1000 MT)	1226	1161	1261	1298	1349	1401	1454	1509
Net imports (1000 MT)	359	287	373	381	414	450	491	532
Total supply (1000 MT)	1585	1448	1634	1679	1762	1851	1944	2041
Food consumption (1000 MT)	1091	887	1015	1056	1099	1144	1191	1238
Feed consumption (1000 MT)	374	411	436	467	502	539	579	622
Seed and waste (1000 MT)	136	113	151	156	162	168	174	181
Ending-Beg. stocks (1000 MT)	-16	37	32	0	0	0	0	0
Wholesale soybean price (Rp/kg)	582	683	780	845	916	992	1075	1166
Farmgate soybean price (Rp/kg)	552	648	740	802	869	942	1020	1106
Real wholesale price (1986 base)	582	630	664	666	668	670	672	675
Peanuts (lepas kulit)								
Area harvested (1000 HA)	601	551	582	604	628	655	684	715
Average yield (MT/HA)	1.07	0.97	0.98	0.99	0.99	1.00	1.01	1.01
Peanut production (1000 MT)	642	533	572	596	623	654	687	723
Net imports (1000 MT)	34	46	28	25	21	14	5	-5
Total supply (1000 MT)	676	579	600	621	644	668	693	718
Food consumption (1000 MT)	606	528	544	563	584	605	627	649
Seed and waste (1000 MT)	71	51	56	58	60	63	66	69
Ending-Beg. stocks (1000 MT)	0	0	0	0	0	0	0	0
Wholesale peanut price (Rp/kg)	1161	1285	1679	1841	2016	2207	2415	2642
Farmgate peanut price (Rp/kg)	503	556	727	797	873	956	1046	1144
Real wholesale price (1986 base)	1161	1185	1429	1450	1471	1491	1511	1530
Sugar (gula pasir)								
Area harvested (1000 HA)	316	345	328	320	315	313	311	309
Average yield (MT/HA)	6.41	6.17	5.79	5.85	5.91	5.97	6.03	6.09

Appendix Table E.3. Continued

Commodity Supply and Use	1986	1987	1988	1989	1990	1991	1992	1993
Sugar production (1000 MT)	2024	2127	1900	1873	1863	1865	1873	1884
Net imports (1000 MT)	162	128	256	164	250	327	401	475
Total supply (1000 MT)	2186	2255	2156	2037	2114	2193	2274	2359
Food consumption (1000 MT)	1942	2155	1988	2062	2139	2218	2299	2384
Ending-Beg. stocks (1000 MT)	244	100	168	-25	-25	-25	-25	-25
Wholesale sugar price (Rp/kg)	622	663	730	788	856	929	1008	1094
Real wholesale price (1986 base)	622	612	621	621	624	627	631	634

APPENDIX F. TYPE AND SOURCES OF DATA FOR A REGIONAL POLICY MODEL

Government Agency	Type of Data
KANWIL	Repelita targets, realization of area, production of various crops, input and output prices
Ministry of Trade	Exports and imports
BULOG/DOLOG	Rice stocks, trade, support prices, and other policy instruments, wholesale and retail prices on rice and sugar
DINAS PERTANIAN	Area, production, productivity and prices for crops (annual and monthly), cropping patterns, rainfall patterns
Biro Pusat Statistik	Regional income, inflation, population, wholesale prices, cost of production, and other economic indicators
Local university	Regional planning tools, affiliated research centers, supply and demand parameters, physical and soil factors, and other related information
Local research stations	Agronomic conditions, local varietal response, rainfall, and other climatic information

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